SDMS# 2119779

Site Location

Site Name:	ORPHAN MINE			**Site Id:**	0908478
Address:	West Rim Drive			**State Id:**	
City, ST, Zip:	Grand Canyon AZ 86023 -			**Site Epa Id:**	AZN000908478
County Name:	Coconino	**FIPS Code:**	04005	**Primary SSID:**	
Navajo Nation:	No	**SMSA:**		**Region:**	09
Congr District:		**USGS Hydro Unit:**		**Site Size:**	
USGS Quadrant:		**Site Alias EPA ID:**		**Unit:**	
Child Site Exits:	No	**FUDS:**		**Site Parent Id:**	
Directions to Site:					

Site Status and Description/Operable Units

OU/OU Name:
00 SITEWIDE

Site Short Name:	ORPHAN MINE	**Archive Ind:**	
Owner Operation Type:		**Archive Date:**	00/00/0000
Operational Status:		**NPL Status:**	Not on the NPL
Federal Facility Docket:	Yes	**Non-NPL Status:**	Fed Fac Preliminary Assessment Review Start Needed
Federal Facility Indicator:	Federal Facility	**Date:**	11/10/1993
Responsible Federal Agency:		**ERS Exclusion:**	
RCRA Site:		**ERS Exclusion Date:**	00/00/0000
Primary RPM:		**Final Assessment Decision:**	No
Primary OSC:		**Final Assessment Decision Date:**	00/00/0000
		NFFA:	
		NFFA Date:	00/00/0000

Site Alias

Listing	Alias Name
	ORPHAN MINE

Site Type

Main Site Type:	Site Type Subcategory:
Mining	Metals

Site Latitude/Longitude

Site Discovery/Initiation

Removal Initiation Date: **Identified By:** States **Discovery Date:** 11/10/1993

Description:

Site Actions:

OU	Action Name	Action ID	LD	Planned Start	Planned Complete	Actual Start	Actual Complete	Qual
00	DISCOVERY	DS001	F				11/10/1993	

Created By: HCHEUNG **Created Date:** 03/01/2007 **Modified By:** HCHEUNG **Modified Date:** 03/01/2007

5590

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

OCT 1 2 2007

Shawn P Mulligan
National Park Service
1050 Walnut Street, Suite 220
Boulder, Colorado 80302

RE: Orphan Mine
EPA ID# AZN000608478

Dear Mr. Mulligan:

Enclosed is an Abbreviated Preliminary Report of the Orphan Mine site. This report contains the results of an evaluation conducted by the U.S. Environmental Protection Agency (EPA) under Section 104 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended [42 U.S.C. 9404], commonly known as Superfund. The purpose of the Preliminary Assessment is to determine whether this site may qualify for placement on the National Priorities List (NPL).

Based on currently available information contained in the enclosed report, EPA has determined that no further assessment is warranted.

Please forward any written comments on the enclosed report to:

Philip Armstrong
Site Assessment Manager
U.S. Environmental Protection Agency
75 Hawthorne Street, SFD-9-1
San Francisco, CA 94105

If you have any questions, please call Philip Armstong at 415/972-3098.

Sincerely,

Deborah Schechter, Chief
States, Tribes, and Site Assessment Section
Superfund Division

Enclosure

cc: Tim Erwin, Arizona Department of Environmental Quality

ABBREVIATED PA REPORT CHECKLIST

Site Name: Orphan Mine EPA ID#: AZN000908478

- [ ] 1. Cover Memorandum/Sign-off Sheet to EPA
- [x] 2. Transmittal List and Transmittal Letter
- [x] 3. HRS Scoresheet Packet, including Rationale - prepared for NPS - reviewed by Carol
- [x] 4. Abbreviated PA Report
- [x] 5. EPA Region 9 Remedial Site Assessment Decision Form
- N/A [ ] 6. Site Reconnaissance Report/Photo Documentation
- [x] 7. Latitude and Longitude Calculations Worksheet - ~~requested from NPS~~
- [x] 8. References (refer to *Guidelines for References,* Copying Referenced Materials, in Section 30 of the *Reference Handbook for the Site Assessment Project*) - PA report attached
- N/A [ ] 9. Region 9 Site Screening/Prioritization Checklist
- [ ] 10. CERCLIS Archive Site Memo to File - for NFA sites only

Review conducted by: D. Arnold [illegible] 9/18/07

Abbreviated Preliminary Assessment Report
Orphan Mine
Grand Canyon, Coconino, Arizona
EPA ID No. AZN000908478

Superfund Division
States, Tribes, and Site Evaluation Section
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, California 94105

June 2007

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List of Appendices

ABBREVIATED PRELIMINARY ASSESSMENT REPORT

Site Information:	Orphan Mine West Rim Drive Grand Canyon, Arizona 86023
Site EPA ID#:	AZN000908478
Prepared by:	Philip Armstrong
Prepared for:	EPA Region 9
Date:	June 1, 2007

1.0 Introduction

According to information in the Federal Agency Hazardous Waste Compliance Docket database, this facility was listed on the Federal Agency Hazardous Waste Compliance Docket on November 10, 1993 based on a request by the U.S. Department of the Interior, National Park Service. The U.S. Environmental Protection Agency, Region 9 (USEPA), under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act or 1980 (CERCLA), reviewed the following documents provided by the U.S. Department of the Interior, National Park Service in conducting a Federal Facility Preliminary Assessment Review for Orphan Mine:

Harding Lawson Associates, Phase I Preliminary Assessment, Orphan Mine, Grand Canyon National Park, Arizona, July 6, 1993

Provenzano, Kris, U.S. Department of the Interior, National Park Service, Intermountain Region, Intermountain Support Office - Denver, letter to Johnson, Jerry, U.S. Environmental Protection Agency, Region 9, w/enclosures, July 27, 1998

2.0 Apparent Problem

According to the Phase I Preliminary Assessment completed for the National Park Service in July 1993, the Orphan Mine is an inactive uranium mine located on the South Rim of the Grand Canyon. Copper ore was mined from 1906 to 1959. Uranium ore was mined from 1951 until April 1969. The site consists of a 3-acre upper mine area at the canyon rim with scattered mine waste and a lower mine areas approximately 1000 feet in elevation below the rim with several adits and a large vertical mine shaft. The site is contaminated with radionuclides, including uranium, thorium, and radium isotopes, as well as heavy metals, including copper, arsenic, and lead. Diesel fuel was once stored onsite in at least one UST. Contents of an alleged second UST are unknown.

3.0 Site and Hazard Ranking System Considerations

The significant HRS factors associated with the site include:

Groundwater: There are no drinking water wells within 4 miles of the site.

Surface water: There is no suspected release to surface water. The site is in a national park.

Soil exposure and air: There is a release to the soil and the air on the site. There are no residents, schools, or regularly present workers with 1 mile of the site. The site is on a national park, which is a terrestrial sensitive environment. However, there are not enough targets to make these pathways significant.

4.0 References

U.S. Environmental Protection Agency, Federal Agency Hazardous Waste Compliance Database

Harding Lawson Associates, Phase I Preliminary Assessment, Orphan Mine, Grand Canyon National Park, Arizona, July 6, 1993

Appendix A
Transmittal List for Orphan Mine AZN000908478:

Shawn P. Mulligan
National Park Service
1050 Walnut Street, Suite 220
Boulder, Colorado 80302

Tim Erwin
Arizona Department of Environmental Quality
1110 West Washington Street
Phoenix, AZ 85007

Appendix B
Latitude and Longitude Calculations

Appendix D
Abbreviated Preliminary Assessment Checklist

ABBREVIATED PRELIMINARY ASSESSMENT CHECKLIST

This checklist can be used to help the site investigator determine if an Abbreviated Preliminary Assessment (APA) is warranted. This checklist should document the rationale for the decision on whether further steps in the site investigation process are required under CERCLA. Use additional sheets, if necessary.

Checklist Preparer: __Philip Armstrong, Site Assessment Manager__ (Name/Title) ________6/1/07_________ (Date)

__75 Hawthorne Street, San Francisco, CA 94105_________ (Address) ____415-972-3098_____________ (Phone)

_armstrong.philip@epa.gov______________________________ (E-Mail Address)

Site Name: ____Orphan Mine______________________________

Previous Names (if any): ______________________________

Site Location: __________West Rim Drive______________________ (Street)

__________Grand Canyon______________ , __AZ__ (ST) ___86023___________ (Zip) (City)

Latitude: ______________________ **Longitude:** ______________

Describe the release (or potential release) and its probable nature: According to the Phase I Preliminary Assessment completed for the National Park Service in July 1993, the Orphan Mine is an inactive uranium mine located on the South Rim of the Grand Canyon. Types of chemicals known or suspected to be present include radionuclides associated with scattered ore and waste rock. Diesel fuel was once stored onsite in at least one UST. Contents of an alleged second UST are unknown.

Part 1 - Superfund Eligibility Evaluation

If all answers are "no" go on to Part 2, otherwise proceed to Part 3.		YES	NO
1.	Is the site currently in CERCLIS or an "alias" of another site?	☐	x☐
2.	Is the site being addressed by some other remedial program (Federal, State, or Tribal)?	x☐	☐
3.	Are the hazardous substances potentially released at the site regulated under a statutory exclusion (e.g., petroleum, natural gas, natural gas liquids, synthetic gas usable for fuel, normal application of fertilizer, release located in a workplace, naturally occurring, or regulated by the NRC, UMTRCA, or OSHA)?	☐	x☐
4.	Are the hazardous substances potentially released at the site excluded by policy considerations (i.e., deferred to RCRA corrective action)?	☐	x☐
5.	Is there sufficient documentation to demonstrate that no potential for a release that could cause adverse environmental or human health impacts exists (e.g., comprehensive remedial investigation equivalent data showing no release above ARARs, completed removal action, documentation showing that no hazardous substance releases have occurred, or an EPA approved risk assessment completed)?	☐	x☐

Please explain all "yes" answer(s).

_____The National Park Service is the lead agency for a removal action at the site.

Part 2 - Initial Site Evaluation

For Part 2, if information is not available to make a "yes" or "no" response, further investigation may be needed. In these cases, determine whether an APA is appropriate. Exhibit 1 parallels the questions in Part 2. Use Exhibit 1 to make decisions in Part 3.

If the answer is "no" to any of questions 1, 2, or 3, proceed directly to Part 3.	**YES**	**NO**
1. Does the site have a release or a potential to release?	x☐	☐
2. Does the site have uncontained sources containing CERCLA eligible substances?	x☐	☐
3. Does the site have documented on-site, adjacent, or nearby targets?	x☐	☐

If the answers to questions 1, 2, and 3 above were all "yes" then answer the questions below before proceeding to Part 3.	**YES**	**NO**
4. Does documentation indicate that a target (e.g., drinking water wells, drinking surface water intakes, etc.) has been exposed to a hazardous substance released from the site?	x☐	☐
5. Is there an apparent release at the site with no documentation of exposed targets, but there are targets on site or immediately adjacent to the site?	☐	x☐
6. Is there an apparent release and no documented on-site targets or targets immediately adjacent to the site, but there are nearby targets (e.g., targets within 1 mile)?	☐	x☐
7. Is there no indication of a hazardous substance release, and there are uncontained sources containing CERCLA hazardous substances, but there is a potential to release with targets present on site or in proximity to the site?	☐	x☐

Notes:

#4: There is a release to the soil and the air. The site is on a terrestrial sensitive environment, i.e., a ~~national park. However, there are insufficient targets to make these significant pathways. Consequently, a No~~ Further Remedial Action Planned decision can be made for this site without completing a full PA.

EXHIBIT 1
SITE ASSESSMENT DECISION GUIDELINES FOR A SITE

Exhibit 1 identifies different types of site information and provides some possible recommendations for further site assessment activities based on that information. You will use Exhibit 1 in determining the need for further action at the site, based on the answers to the questions in Part 2. Please use your professional judgement when evaluating a site. Your judgement may be different from the general recommendations for a site given below.

Suspected/Documented Site Conditions		APA	Full PA	PA/SI	SI
1. There are no releases or potential to release.		Yes	No	No	No
2. No uncontained sources with CERCLA-eligible substances are present on site.		Yes	No	No	No
3. There are no on-site, adjacent, or nearby targets.		Yes	No	No	No
4. There is documentation indicating that a target (e.g., drinking water wells, drinking surface water intakes, etc.) has been exposed to a hazardous substance released from the site.	Option 1: APA ➪ SI	Yes	No	No	Yes
	Option 2: PA/SI	No	No	Yes	NA
5. There is an apparent release at the site with no documentation of exposed targets, but there are targets on site or immediately adjacent to the site.	Option 1: APA ➪ SI	Yes	No	No	Yes
	Option 2: PA/SI	No	No	Yes	NA
6. There is an apparent release and no documented on-site targets and no documented targets immediately adjacent to the site, but there are nearby targets. Nearby targets are those targets that are located within 1 mile of the site and have a relatively high likelihood of exposure to a hazardous substance migration from the site.		No	Yes	No	No
7. There is no indication of a hazardous substance release, and there are uncontained sources containing CERCLA hazardous substances, but there is a potential to release with targets present on site or in proximity to the site.		No	Yes	No	No

Part 3 - EPA Site Assessment Decision
When completing Part 3, use Part 2 and Exhibit 1 to select the appropriate decision. For example, if the answer to question 1 in Part 2 was "no," then an APA may be performed and the "NFRAP" box below should be checked. Additionally, if the answer to question 4 in Part 2 is "yes," then you have two options (as indicated in Exhibit 1): Option 1 -- conduct an APA and check the "Lower Priority SI" or "Higher Priority SI" box below; or Option 2 -- proceed with a combined PA/SI assessment.

Check the box that applies based on the conclusions of the APA:

x☐ NFRAP
☐ Higher Priority SI
☐ Lower Priority SI
☐ Defer to RCRA Subtitle C
☐ Defer to NRC
☐ Refer to Removal Program - further site assessment needed
☐ Refer to Removal Program - NFRAP
☐ Site is being addressed as part of another CERCLIS site
☐ Other: ______________________

Regional EPA Reviewer: ___Philip Armstrong_ Philip Armstrong ____ __6/1/07______
Print Name/Signature Date

PLEASE EXPLAIN THE RATIONALE FOR YOUR DECISION:

As discussed in the Phase I Preliminary Assessment completed for the National Park Service in July 1993, the HRS factors associated with this site are as follows:

* There are no drinking water wells within 4 miles of the site.

* There is no suspected release to surface waters. The site is in a national park which is considered a sensitive environment.

* There is a release to the soil and the air on the site. The site is on a terrestrial sensitive environment, i.e., a national park. However, there are insufficient targets on the site to make these significant pathways.

NOTES:

Appendix E
Remedial Site Assessment Decision – EPA Region IX

REMEDIAL SITE ASSESSMENT DECISION - EPA REGION IX

EPA ID: AZN000908478 **Site Name:** ORPHAN MINE **State ID:**

Alias Site Names: NPS-ORPHAN MINE
ORPHAN MINE

City: GRAND CANYON **County or Parish:** COCONINO **State:** AZ

Refer to Report Dated: 06/01/2007 **Report Type:** FED FAC PRELIMINARY ASSESSMENT REVIEW 001

Report Developed by: EPA/In House

DECISION:

[X] **1. Further Remedial Site Assessment under CERCLA (Superfund) is not required because:**

[X] **1a. Site does not qualify for further remedial site assessment under CERCLA (No Further Remedial Action Planned - NFRAP)**

[ ] **1b. Site may qualify for action, but is deferred to:**

[ ] **2. Further Assessment Needed Under CERCLA:**

2a. Priority: [ ] **Higher** [ ] **Lower**

2b. Other: (recommended action)NFRAP (No Futher Remedial Action Planned

DISCUSSION/RATIONALE:

As discussed in the Phase I Preliminary Assessment completed for the National Park Service in July 1993, the HRS factors associated with this site are as follows
* There are no drinking water wells within 4 miles of the site
* There is no suspected release to surface waters The site is in a national park which is considered a sensitive environment
* There is a release to the soil and the air on the site The site is on a terrestrial sensitive environment, i e , a national park However, there are insufficient targets on the site to make these significant pathways

The U S Environmental Protection Agency (EPA) has determined that no further remedial action by the Federal Superfund program is warranted at the referenced site, at this time The basis for the no further remedial action planned (NFRAP) determination is provided in the attached document A NFRAP designation means that no additional remedial steps under the Federal Superfund program will be taken at the site unless new information warranting further Superfund consideration or conditions not previously known to EPA regarding the site are disclosed In accordance with EPA's decision regarding the tracking of NFRAP sites, the referenced site may be removed from the CERCLIS database and placed in a separate archival database as a historical record if no further Superfund interest is warranted Archived sites may be returned to the CERCLIS site inventory if new information necessitating further Superfund consideration is discovered

Site Decision Made by: PHILIP ARMSTRONG

Signature: Philip Armstrong **Date:** 06/01/2007

EPA Form # 9100-3

5590-2119779

Harding Lawson Associates

A Report Prepared for

National Park Service
Denver Service Center
12795 West Alameda Parkway
P.O. Box 25287
Denver, Colorado 80225

PHASE I PRELIMINARY ASSESSMENT
ORPHAN MINE
GRAND CANYON NATIONAL PARK. ARIZONA

HLA Job No. 22040-002

by

Jeffrey F. Ludlow
Senior Geologist

Susan Kennedy
Senior Environmental Scientist

Harding Lawson Associates
303 Second Street, Suite 630 North
San Francisco, California 94107
415/543-8422

July 6, 1993

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

EXECUTIVE SUMMARY

Harding Lawson Associates (HLA) completed a Phase I Preliminary Assessment (PA) of the Orphan Mine in Grand Canyon National Park, Arizona, under the Denver Service Center Task Order No. 1443T0200-92-126. The PA was performed in accordance with "Guidance for Performing Preliminary Assessments under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Guidance Document," dated 1991 (EPA, 1991b). The purpose of the PA is to provide information that will be used to assess if the Orphan Mine site poses a threat to human health and the environment and requires further investigation under the EPA CERCLA site assessment process.

The site is located approximately 1.5 miles northwest of the South Rim Village and consists of an approximately 3-acre upper mine area at the Canyon Rim with numerous abandoned sheds and scattered mine waste and a lower mine area approximately 1000 feet in elevation below the canyon rim with several adits and a large "glory hole". Copper ore was mined from 1906 to 1959. Uranium ore was mined from 1951 until April 1969.

Several radionuclide surveys were performed at the site between 1981 and 1986. Results of these previous surveys suggest that gamma radiation up to 3.0 millirems per hour (mR/hr) emanates from mine waste at the site. Some of the previous investigators recommended that mine waste be reclaimed by filling the main shaft at the upper mine area with the waste at the site, and then capping the shaft with concrete.

The site is on the Coconino Plateau of the Colorado Plateau Geomorphic Province. The shaft from the upper mine area encounters Kaibab Limestone, Coconino Limestone, Hermit Shale, and Supai Sandstone and Shale. Groundwater is expected to occur at a depth greater than 1000 feet below the canyon rim in the Coconino Sandstone. The nearest permanent surface water to the Orphan Mine is the Colorado River, approximately 2 miles and 4600 vertical feet below the upper mine area. The mean annual precipitation at the site is approximately 16 inches occurring principally in the summer and winter seasons, as afternoon thunderstorms and winter snowfall. Mean maximum temperatures rang from 41 degrees Fahrenheit (^{O}F) in January to 84^{O}F in July. Mean minimum temperatures range from 18^{O}F in January to 54^{O}F in July. Generally, wind flows up and down the canyon from the north-northeast to the south and southeast, from 2 to 4 meters per second.

On September 1 and November 4 and 5, 1992, HLA personnel visited the Orphan Mine to assess current site conditions and interview personnel who previously worked at the mine. The site slopes gently down to the southeast and is primarily covered with grass and bushes. Other features observed at the site include red cinders used as a road base for truck traction, a concrete ore storage pad at the southeast corner, several concrete foundations from former site buildings, a shed containing an air compressor, and the main shaft headframe at the canyon rim. Mine waste was observed scattered around the inside perimeter of the fenced site and outside the fenced area to the west. According to a former mine employee, some ore may have spilled over the edge of the trucks as they circled the site after retrieving ore from the hopper beneath the main shaft headframe.

On September 1, 1992, HLA observed one underground storage tank that reportedly contained diesel at the site. Approximately 5 inches of liquid remained in the UST. During the November site visit, a reconnaissance radionuclide survey was performed at the upper mine area. Background beta plus gamma radiation ranged from 0.01 to 0.04 mR/hr. Beta plus gamma radiation above this background level averaged 5 to 10 mR/hr primarily around the perimeter of the fenced area. Additionally, an area 60 feet west of the mine, outside the fenced area, had beta plus gamma radiation readings above the background level. The radiation readings were taken on individual rocks at the ground surface and decreased rapidly to background conditions a few inches away from the rock. HLA observed the lower mine area from Maricopa Point. Features visible were a large "glory hole" and remnants of the aerial tramway that led from the upper mine area to the lower mine area.

HLA evaluated the groundwater pathway, surface water pathway, soil exposure pathway, and air pathway, in accordance with the PA guidance document, to assess potential human and ecological exposures to contaminants from the site. These pathways were evaluated within a 4-mile radius of the site and for 15 miles downstream of the site on the Colorado River. No active wells were identified within a 4-mile radius of the site; therefore, the groundwater pathway was not scored and part of the PA.

The potential for chemical migration from site sources to intermittent perennial surface water bodies is considered low. Runoff from the upper mine area flows away from the canyon and is presumably lost to evaporation and ground infiltration. Runoff from the lower mine area is toward Horn Creek, an intermittent tributary to the Colorado River. No drinking water sources were identified within 15 miles downstream of the lower mine area on Horn Creek or the Colorado River. However, the Colorado River is used as a recreational fishery.

Target receptors considered for the soil exposure pathway are workers, residents, and people attending schools and daycare centers within 1 mile of the site, and terrestrial sensitive environments. The potential threat associated with the soil exposure pathway is considered low because there are no residents, schools, or regularly present workers within 1 mile of the site. However, the site is considered a terrestrial sensitive environment under this pathway because it is within the Grand Canyon National Park.

Radionuclides and other metals that may be present in surface soil on or near the site could migrate from the site via the air pathway. Elevated beta and gamma radiation release to the air are suspected based on previous radionuclide surveys. Targets receptors considered under the air pathway include residents, students, and worker population within 4 miles of the site, and sensitive ecological environments within 1/2 mile of the site.

The overall site score using the PA scoresheets and data from the four exposure pathways was 13.47. According to EPA guidance, sites (such as the Orphan Mine) that score less than 28.50 receive a recommendation for no further remedial action under the CERCLA site assessment process.

HLA recommends that no one should enter the mine tunnels unless the radiation levels are lowered. If the GCNP wishes to open the upper site area for public access site reclamation should at least include mitigating physical site hazards. Based on the results of the PA, HLA is unable to assess if visitors and park employees direct contact with the site waste would cause adverse health effects. If the site is opened, either a baseline risk assessment should be performed to assess health effects resulting from direct exposure or the site should be reclaimed to background conditions. For either scenario, the extent of mine waste at the upper and lower mine areas and the magnitude of radiation should be assessed. The investigation and UST closure would cost approximately $43,098. A baseline risk assessment would cost approximately $24,922. Since the site is not fully characterized, HLA is unable to present cost projections for site reclamation.

HLA recommends that the identified underground storage tank be closed in accordance with the Arizona Department of Environmental Quality regulations. This would cost approximately $10,500.

1.0 INTRODUCTION

This Phase I Preliminary Assessment (PA) of the Orphan Mine in Grand Canyon National Park (GCNP), Arizona, was prepared by Harding Lawson Associates (HLA) to satisfy the requirements of Task Order 1443T0200-92-126 authorized by the National Park Service (NPS) Denver Services Center (DSC) on September 30, 1992. This PA has been prepared in accordance with (1) the Federal Agency Hazardous Waste Compliance Docket Reference Manual (EPA, 1991a), and (2) Guidance for Performing Preliminary Assessments Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA, 1991b).

The purpose of a PA is to provide information that will be used to distinguish sites that pose little or no threat to human health and the environment from sites that require further investigation under EPA's CERCLA site assessment process. The PA also identifies sites requiring emergency response actions. The structure of the PA follows the structure of the Hazard Ranking System (HRS) model (55 FR 51532, December 14, 1990), the mechanism used by EPA to evaluate sites for inclusion on the National Priorities List (NPL). By definition, the PA is a limited-scope investigation that emphasizes gathering information on people and resources that might be threatened by chemicals migrating from the site. The PA generally involves a site reconnaissance without collection of environmental samples (EPA, 1991b).

This PA is the result of observations made during a site reconnaissance on September 1 and November 4 and 5, 1992, and interviews of NPS and state agency personnel conducted by HLA.

The objectives of the PA for the Orphan Mine are to:

1. Provide physical descriptions of potential sources of hazardous substances associated with the site.
2. Identify human and environmental target receptors associated with the four pathways: groundwater, surface water, soil exposure, and air.
3. Evaluate the likelihood of hazardous substances migration from the site via groundwater, surface water, and air.

4. Evaluate the likelihood for direct contact with soil by human and environmental targets.

5. Determine whether CERCLA a Site Inspection (SI) is warranted.

2.0 SITE DESCRIPTION

This section provides general site descriptive information including the site location, site history, previous investigations, geology, surface and subsurface hydrology, and meteorology.

2.1 Site Location And Description

The Orphan Mine is located in GCNP midway between Powell Memorial and Maricopa Point, approximately 1 1/2 miles northwest of South Rim Village, Coconino County, Arizona (Plate 1). The site lies within Township 31 North, Range 2 East, Section 14 (Plate 2). The site is comprised by an upper mine area at the canyon rim and a lower mine area approximately 1000 feet in elevation below the canyon rim. Access to the site is by West Rim Drive from South Rim Village. The upper mine area is surrounded by a 6-foot high cyclone fence on the west, east, and south sides, and the canyon rim on the north side. Access to the site is through a locked gate. The lower mine area is accessible only by foot along the base of the Coconino Sandstone from the Bright Angel Trail.

The upper mine is an approximately 3-acre relatively flat area surrounded by a cyclone fence and the Canyon rim. The majority of this area is covered with grass, bushes, and aggregate materials. Several abandoned sheds and concrete/asphalt pads exist throughout the site. The main adit headframe and ore hopper are located at the north edge of the site.

The lower mine is an approximately 1-acre steeply sloping area approximately 1000 feet in elevation below the canyon rim. A few abandoned sheds and a large mining subsidence hole (glory hole) connected to underground adits and shafts are visible at the lower mine area. Additionally, remnants remain of a tramway to the upper mine area.

2.2 Site History

Daniel L. Hogan and Henry Ward filed the claim for copper mining in 1893 at the lower mine area and patented it in 1906. Copper mining occurred at the lower mine area at various times between 1906 and 1959. The claim was acquired by Madeline Jacobs in 1946 (Magleby, 1961). As a result of the discovery of uranium at the site in 1951, the mineral rights were leased in 1953. The rights were later acquired by a subsidiary of Western Gold and Uranium Inc., later renamed Western Equities, Inc. (Hom, 1986).

In 1956, Western Gold built an aerial tramway from the lower adit area to the rim to facilitate removal of uranium ore. From 1956 to 1959, ore production averaged 1,000 tons per month of 1 percent uraninite (U_3O_8).

In 1959, a shaft was driven from the top of the tramway to 1600 feet below the canyon rim to the lower adits to haul ore, men, and materials to and from the lower mine workings (Hom, 1986). Production in 1960 averaged 6400 tons per month of 0.3 percent U_3O_8 (Hom, 1986). Most of the ore was trucked to the Tuba City, Arizona mill for processing. Some ore was also shipped by railroad to a uranium mill in Grants, New Mexico (Hom, 1986).

In 1961, the permitted mining limit for ore deposits in GCNP was reached. Under public law of 1962, additional ore could be mined until 1987, at which time the site would become NPS property (Hom, 1986).

The Cotter Corporation purchased the mine in 1967 and continued mining until April 1969, at which time all mining operations at the site ceased (Hom, 1986). In February 1981, Republic Mining Enterprises purchased the Orphan Mine (Hom, 1986). In 1987 the GCNP acquired the site.

2.3 Previous Investigations

Results of several radionuclide surveys in the GCNP files were reviewed by HLA. Throughout the 1980s, Arizona State University students performed radionuclide surveys of the Orphan Mine and other areas of the GCNP. These surveys were performed as class exercises, and the objectives, results, and conclusions were not clearly presented in the reports and did not contain appropriate quality assurance. Therefore, the results will not be considered as background information.

In 1981, the U.S. Department of Labor Mine Safety and Health Administration (MSHA) prepared a report entitled "Report of Radiation Survey, Orphan Mine, Grand Canyon National

Park, Arizona," dated November 5 through 7, 1981 (Day, 1981). The survey was performed in response to requests by the NPS for information regarding radiation and the current status of underground workings at the site. On November 5, 1981, gamma radiation up to 3.0 millirems per hour (mR/hr) was measured at the main shaft area of the upper mine workings. In the middle of the upper mine workings near the guard's home site, 0.05 to 0.10 mR/hr of gamma radiation was measured. On November 6, 1981, an underground survey was conducted. At approximately 700 feet below the canyon rim, several measurements were taken. The ventilation airflow volume was 7800 cubic feet per minute; temperature was 3 degrees Fahrenheit, with the relative humidity of 82 percent. Detector tubes indicated no carbon monoxide was present. Bistable air samples indicated 500 parts per million (ppm) carbon dioxide, 0.0 ppm carbon monoxide, and 20.91 percent oxygen. Radon daughter samples were at 49.8 WL. At 1500 feet below the rim, at the shaft bottom, two radon daughter samples contained 54.8 and 60.6 WL. Gamma radiation measurements indicated 4 to 5 mR/hr. Based on the results of the survey, the MSHA recommended that no one enter the mine unless work is done to lower the radiation levels. Additionally, they recommended that since the guard's home site area was exposed to gamma measurements of 0.05 to 0.10 mR/hr, which would exceed the maximum allowable 0.17 rem dose exposure per year, that the guard home site be moved away from the mine dump areas. The MSHA did not specify the basis for the 0.17 rem exposure standard. The MSHA did not present a site plan indicating measurement locations, nor did they tabulate the data.

On March 3, 1986, Landmark Reclamation (Landmark, 1986) performed a radiological survey utilizing an Eberline PRM-7 Microrem meter. Landmark Reclamations' assessment was performed to assess the extent and magnitude of radiological contamination in an around the upper mine area. The assessment was included in a proposal for site reclamation. Their surveys were performed on a 25-foot grid over the yard area taking measurements with the meter at waist height. Additionally, they collected soil samples from six locations at various depths throughout the mine and surrounding area to assess uranium content in the soil to correlate between total gamma readings and soil uranium content. The soil sample results were not presented in the Landmark Reclamation report. Radionuclide survey results ranged from 0.08 to 0.9 mR/h. The highest readings were measured at the southeast corner of the upper mine area near the concrete ore pad and at the upper mine shaft opening. Plate 3 presents results of the Landmark Reclamation radionuclide survey. Based on the results of the assessment, and the high visitor use at this area, Landmark Reclamation recommended that the residual radioactive material be excavated from the site and disposed down the 1600-foot shaft at the rim and the remaining material buried at an offsite location. Additionally, they recommended that the shaft opening, once the material was placed inside, be sealed to prevent radon gas from emanating to the surface. They further recommended that the tramway structure and lower mine bunk house area and residual mining equipment be removed. Their final recommendations included recontouring the site and planting native vegetation.

In June 1986, the U.S. Department of Interior Bureau of Land Management (BLM) completed a reclamation report for the Orphan Mine. The results of the BLM radiological survey at the upper and lower mine area using an Eberline PRM-7 Microrem meter at waist height had eight readings ranging from 0.11 to 3.2 mR/hr. The highest reading of 3.2 mR/hr was in an adit at the lower mine workings. The BLM report did not contain a legible site plan indicating reading locations. The BLM recommended that the material with highest radiation readings in and around the fenced upper mine area be deposited into the mine shaft. After the material is placed in the shaft, they recommended that the shaft be sealed with 4-foot concrete cap, and then covered with 2 feet of top soil. At the lower mine workings, the BLM recommended that a heavy-duty chain-link fence be constructed around the mining subsidence hole to prevent wildlife and hikers from falling in. The BLM recommended that all adits and raises be sealed by exploding dynamite to prevent entry into the underground mine workings and to prevent build-up of naturally occurring spring water in the mine adits. The BLM concluded that reclamation of the Orphan Mine site should be implemented by the NPS to minimize residual hazards to park visitors from the past mining operation. However, they stated that reclamation of the site need not be the highest priority because of the short radiological exposure time experienced by park visitors.

2.4 Geology

The site is on the Coconino Plateau of the Colorado Plateau geomorphic province. The upper mine working area is on recent soils of the Kaibab Formation Limestone. The shaft from the upper mine area encounters Paleozoic age Kaibab Limestone, the Toroweap Formation, Coconino Sandstone, Hermit Shale, and the Supai Formation (sandstone and shale) (Gornitz et al., 1970). The ore body is located in a breccia pipe filled with rock fragments from the Coconino Sandstone and angular siltstone, shale, and limestone breccia from the Supai and Hermit Formations. These rocks collapsed into a solution cavity formed in the Redwall Limestone. The primary ore was uraninite, pyrite, chalcocite, tennantite, chalcopyrite, and galena (Gointz et al., 1970).

2.5 Surface And Subsurface Hydrology

The nearest permanent surface water feature to the Orphan Mine is the Colorado River, which forms the base of the Grand Canyon approximately 2 overland miles and 4600 vertical feet below the upper mine area. The Colorado River flows westward through GCNP and Lake Mead National Recreation Area before turning southwestward and eventually emptying into the Gulf of California.

Based on a review of the U.S. Geological Survey topographic map (1962) and observations made during the site visits, surface water runoff from the upper mine area flows southeast off of the site and away from the canyon. Runoff water from the upper mine area would probably be lost to evaporation and ground infiltration. Seepage and runoff from the lower mine area flows toward Horn Creek, an intermittent tributary to the Colorado River (Plate 4).

Groundwater in the Coconino Plateau originates in the San Francisco Peaks/Williams areas, the Aubrey Cliffs area, and the highlands surrounding South Rim Village. Water from precipitation in the highlands near South Rim Village percolates through a series of permeable and semi-permeable strata creating a number of perched water zones. Most of these zones yield little water for development. However, at elevations approximately 1000 feet below the surface of the rim, the Coconino Sandstone, where underlain by the Hermit Shale, may provide a low yield of water to wells. The saturated thickness of the perched aquifer depends on the relative permeability of Hermit Shale, amount of precipitation, and any local geologic structural influences. Groundwater perched on the Hermit moves radially until finally percolating through the Hermit and the Redwall Limestone into the Muav Limestone (Johnson, no date).

2.6 Meteorology

The following climatological data for the South Rim of GCNP was summarized from the Final Environmental Impact Statement, GCNP (NPS, no date). Mean annual precipitation is approximately 16 inches. Almost equal amounts of precipitation are received in the winter and summer seasons; spring and fall are relatively dry. Precipitation events in the summer occur when afternoon thunderstorms form as a result of solar heating of the canyon walls. In the winter season, middle latitude storms carrying Pacific moisture propagate eastward depositing snow on the South Rim. Generally, the winter storms are light to moderate in intensity; however, occasionally severe winter storms will pass through the area.

The mean maximum temperature ranges from 41 degrees Fahrenheit (^{O}F) in January to 84^{O}F in July. The mean annual temperature is 49^{O}F. Mean minimum temperatures range from 18^{O}F in January to 54^{O}F in July. Generally, temperatures increase with decreasing elevation in the canyon.

As a rule, the wind flows up and down the canyon from north-northeast to the south and south-southwest direction which reverses diurnally. Wind speeds are typically low and range from 2 to 4 meters per second. Night-time inversions are common in the canyon.

3.0 WASTE CHARACTERISTICS

The initial step in evaluating waste characteristics for the PA is to identify sources at the site. EPA guidance (1991b) defines a source as an area where a hazardous substance may have been deposited, stored, disposed, or placed. Soil that may have become contaminated as a result of hazardous substance migration is also considered a source. This section discusses the information gathered during the site visits, and the rationale for source identification and evaluation. Also discussed in this section are applicable UST, mine remediation, and radiation exposure regulations. Plate 3 illustrates the site plan. Appendix A presents the PA information form, Appendix B presents the PA Scoresheets, and Appendix C presents site photographs.

3.1 Site Visit

On September 1 and November 4 and 5, 1992, HLA personnel visited the Orphan Mine to assess current site conditions. Prior to arriving at the site, HLA personnel interviewed a former mine employee who provided information on past operations. The former mine employee stated that waste rock and lesser amounts of ore would accumulate around the perimeter of the site as the mine trucks exited the site hauling the ore to the offsite mills (GCNP, 1992).

The site slopes gently down to the southeast. The majority of the site was covered with grasses and shrubs. Red cinder was used as a road base for truck traction and also covered much of the site. The concrete ore pad was observed at the southeast corner of the upper mine area. Several concrete foundations from former site buildings were observed in the center of the site. A shed containing an old compressor was observed at the northeast corner of the site adjacent to the canyon rim. A concrete pad and asphalt pad at the west edge of the site was also observed. The former mine employee stated that these pads were used as foundations for a mechanic shop and a parking area.

One underground storage tank (UST) was observed in the middle of the site. The UST was approximately 5-foot-wide by 13-foot-long and contained approximately 5 inches of liquid. The former mine employee stated that the UST was used to store diesel fuel. He stated that a second UST was used adjacent to a concrete pad just north of the center of the site (GCNP, 1992). HLA was unable to assess if the UST still exists.

During the site visit, a reconnaissance radionuclide survey was performed at the upper mine area to assess distribution of radioactive ore and waste rock. Radiation was randomly measured throughout the fenced area and west of the fenced area. Background beta plus gamma radiation outside the fenced area at the southwest corner ranged from 0.01 to 0.04 mR/hr. Beta plus gamma radiation above this background level averaging 5 to 10 mR/hr was observed primarily around the perimeter of the fenced area. Small accumulations of rock overburden and possible ore were observed around the inside perimeter of the fenced area, where the former employee had indicated that trucks had driven. Approximately 60 feet west of the mine outside the fenced area, radiation was detected above the background level at a 200-square-foot area that appeared to be where ore trucks had parked. The radiation readings were also taken above individual rocks at the ground surface. The readings rapidly decreased to background conditions within a few inches from the rocks.

From Maricopa Point east of the upper mine area, HLA observed the lower mine area. A large "glory hole" was observed near the base of the aerial tramway that was formerly used during the mining operation. Seepage water reportedly emanates from a small diameter pipe at the lower mine area (Hom, 1986).

3.2 Source Evaluation

Potential sources of contamination at the Orphan Mine were evaluated according to PA scoring guidance (EPA, 1991b), presented in Appendix B. Site sources were delineated as follows: (1) contaminated soil; (2) the underground storage tank (UST) observed during the site visit; and (3) the UST allegedly present that was not observed at the time of the site visit.

Areas of soil potentially contaminated by radionuclides and metals were conservatively estimated to include (1) the entire three-acre fenced portion of the upper mine area; (2) one additional acre where contaminated soil may be present outside of the fence at the upper mine area; and (3) two acres at the lower mine area where ore and waste rock may have been deposited on the slope. The source of radionuclides at the site is uraninite in the mined ore and waste rock. The ore contained 0.3 percent to 1.0 percent uraninite (Hom, 1986). The waste rock would probably contain lower concentrations of uraninite than the ore. Uraninite (U308) is water soluble in an oxidizing environment.

The UST that was observed during the site visit and the second UST that is allegedly present were also identified as sources. The observed UST was reportedly used to store diesel fuel; contents of the second UST are not known. Tank capacity for each UST was estimated as 5000 gallons.

3.3 Regulatory Framework

The regulatory framework for the site USTs, mine site remediation, and worker and public exposure to radiation are as follows.

Underground Storage Tanks

The State of Arizona through the Arizona Department of Environmental Quality (ADEQ) has regulatory authority for the registration and closure of USTs in accordance with Federal Regulation 40 CFR 280 and Arizona Revised Statute 49, Chapter 6. The regulatory proceedings developed by ADEQ require that USTs be registered prior to removal. The ADEQ requires visual inspection and soil sampling and analysis to determine if the USTs have leaked. Affected soils above the suggested soil cleanup levels will need to be removed and properly disposed or remediated.

Mine Site Remediation

There are no established standards for remediation of uranium mine sites. The U.S. Environmental Protection Agency (EPA) established "Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites" (40 CFR 192 Subpart B). These standards may be appropriate for the Orphan Mine site. The standards for remedial actions at inactive uranium processing sites state:

The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than:

- Five pCi/g [picocuries per gram] averaged over the first 15 cm [centimeters] of soil below the surface, and
- 15 pCi/g averaged over a 15 cm thick layer of soil more than 15 cm below the surface.

Although these standards are not directly applicable to the Orphan Mine site, they may serve as target remediation goals for any subsequent soil excavation at the site.

__Radiation Exposure__

No limits have been established for human exposure to radiation from inactive uranium mine sites. To establish exposure criteria for the Orphan Mine site, standards developed for other locations were considered. For on-site worker exposure (personnel involved in investigation or remediation), the most appropriate standards are established by the Occupational Health and Safety Administration (OSHA) for personnel exposure in restricted radiation areas. This standard limits total personnel exposure to 1.25 rems per calendar quarter (29 CFR 1910.96).

For NPS personnel and Park visitors, the most appropriate radiation exposure standards are those developed by the Nuclear Regulatory Commission (NRC) for licensed facilities. The "Radiation Dose Limits for Individual Members of the Public" developed by NRC state the following (10 CFR 20 Subpart D):

Each licensee shall conduct operations so that-

- The total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem in one year.
- The dose in any unrestricted area from external sources does not exceed 0.002 rem in any one hour.

4.0 PRELIMINARY PATHWAY ANALYSIS

The emphasis of the PA is to evaluate human and environmental targets that may be threatened as a result of chemicals migrating from a site via groundwater, surface water, and air. Emphasis is also placed on evaluating targets that may come into direct contact with site-related chemicals in soil. The preliminary pathway analysis for this report was guided by the PA scoring process (EPA, 1991b). A PA score generated for the Orphan Mine is presented on the PA Scoresheets in Appendix B.

This section provides a discussion of the potential for chemical migration from the Orphan Mine site and the target receptors associated with each pathway. Although the discussion that follows in this section is largely qualitative, scoring criteria are included where applicable.

4.1 Groundwater Pathway

The potential for drinking water contamination from site-related chemicals migrating in groundwater is considered minimal to none. As discussed in Section 2.5, groundwater is present locally only in perched aquifers approximately 1000 feet below the rim surface.

Target populations considered under the groundwater pathway are humans supplied with drinking water from wells within 4 miles of the site. Drinking-water supplies for all park facilities within a four-mile radius of the site are transferred by pipeline from the Roaring Springs on the North Rim. A search conducted by the Arizona Department of Water Resources (1993) indicated no active wells are present within a 4-mile radius of the site, therefore, the groundwater pathway was not scored.

4.2 Surface Water Pathway

The potential for chemical migration from site sources to intermittent or perennial surface water bodies is considered low. Runoff from the upper mine area is away from the canyon, and is presumably lost to evaporation and ground infiltration. Runoff from the lower mine area, where spring water has been reported by the BLM to discharge from adits, is toward Horn Creek, an intermittent tributary to the Colorado River. The headwaters of Horn Creek are approximately 1/2 mile downslope from the lower mine area (USGS, 1962). According to EPA Guidance (EPA, 1991b), the location of the headwaters of Horn Creek is considered the probable point of entry (PPE) of chemicals into surface water (Plate 4). However, concentrations of any chemicals potentially discharged from the lower mine area to the headwaters of Horn Creek would probably be negligible because 1) the percentage of uraninite in the Orphan Mine ore body is low (0.3 to 1.0 percent), 2) the spring water from the lower mine area would probably be diluted by collective runoff leading to the headwaters of Horn Creek, and 3) the distance between the spring water discharge from the lower mine area and the headwaters of Horn Creek is relatively far (0.5 miles). The flow rate of Horn Creek for most of its length is estimated as less than 10 cubic feet per second (cfs) because it is intermittent. However, the flow rate of Horn Creek may increase significantly where it empties into the Colorado River. The flow rate of the Colorado River is quite variable throughout GCNP, ranging between 7000 to 20,000 cfs (Arizona Department of Fish and Game, 1993).

The target distance limit for the surface water pathway is measured as 15 stream miles from the PPE (Plate 4). Targets include humans that might ingest drinking water or fish from downstream surface water bodies, and sensitive environments that occur along the 15 mile target distance limit. The segment of the Colorado River that flows through GCNP has no drinking water intakes, however it is a recreational fishery inhabited by rainbow trout, brown trout, sunchannel catfish, and striped bass (Arizóna Department of Fish and Game, 1993). As reflected by the PA score, site-related chemicals that might reach the Colorado River would be rapidly diluted minimizing the potential for uptake by human food chain organisms.

Sensitive environments considered for the surface water pathway are indicated in PA Table 5 (Appendix B). A national park is considered a sensitive environment receiving the highest available assigned value for that scoring category. In addition, the federal and state endangered humpback chub and razorback sucker inhabit the segment of the Colorado River that flows through GCNP.

Negligible threat to downstream receptors is indicated by the overall surface water pathway score. The score is low because the chemical migration path from the site to Horn Creek is relatively far (1/2 mile), and because the dilution effects of the Colorado River are considered significant.

4.3 Soil Exposure Pathway

Targets considered under the soil exposure pathway are workers, residents, and people attending schools and daycare centers within 1 mile of the site, and terrestrial sensitive environments located on any area of suspected contamination.

GCNP is considered a terrestrial sensitive environment under the soil-exposure pathway, contributing to the target score. However, the overall potential threat associated with the soil exposure pathway as a result of chemicals from the Orphan Mine is considered low because there are no residents, schools, or regularly-present workers within one mile of the site.

4.4 Air Pathway

Radionuclides and other metals that may be present in surface soil on and near the site could migrate from the site via air. The radionuclide reconnaissance survey conducted during the site visit indicated beta plus gamma radiation above background levels is present at ground surface over portions of the upper mine area. A suspected release to air was conservatively assigned in the PA score.

Target receptors considered for the air pathway include resident, student, and worker populations within 4 miles of the site, and sensitive environments within 1/2 mile of the site. There are no resident, students, or workers that are regularly present within one mile of the site. Between 1 and 2 miles there are approximately 2000 residents and 300 students at South Rim Village. A daycare center with the capacity for 100 children is currently under construction at South Rim Village as well. Between 2 and 3 miles from the site an additional resident population of 200 was estimated (Plate 4). No other residents, students or workers were identified (NPS, 1993).

The fact that the site is within a national park accounted for the only significant contribution to the air target score. The overall score for the air pathway, however, is relatively low because regularly present human populations are beyond the distance that large quantities of chemicals would be expected to migrate in air.

5.0 CONCLUSIONS

The Orphan Mine is an inactive uranium mine located on the South Rim of the Grand Canyon. Types of chemicals known or suspected to be present include radionuclides and metals associated with scattered ore and waste rock. Diesel fuel was once stored onsite in at least one UST. Contents of an alleged second UST are not known.

Little threat to human or environmental target receptors is indicated as a result of evaluating the groundwater, surface water, soil exposure, and air pathways using PA scoring procedures. The most heavily weighted scoring factor was assigned on the basis of the presence of the site within a national park.

The overall site score using the standard PA score sheets was calculated as 13.47 (Appendix B). According to EPA guidance (EPA, 1991b), sites that score 28.50 or greater receive a further action recommendation, while sites that score less than 28.50 achieve the status "Site Evaluation Accomplished". The site score for the Orphan Mine indicates the site would not proceed further in the CERCLA site assessment process.

HLA concurs with the MSHA recommendations that no one should enter the mine tunnels unless the radiation levels are lowered. If the GCNP wishes to open the upper site area for public access. HLA concurs with the BLM recommendation for site reclamation. If the site is opened, reclamation should at least include mitigating physical site hazards. Based on the results of the PA, HLA is unable to assess if visitors and park employees direct contact with the site waste would cause adverse health effects. If the site is opened, either a baseline risk assessment should be performed to assess health effects resulting from direct exposure or the site should be reclaimed to background conditions. For either scenario,, the extent of mine waste at the upper and lower mine areas and the magnitude of radiation should be assessed. HLA presents a site investigation work plan and cost estimate details for completing the investigation in Appendix D. The investigation and UST closure would cost approximately $43,098. A baseline risk assessment would cost approximately $24,922, as detailed in Table

D-2 in Appendix D. Since the site is not fully characterized, HLA is unable to present cost projections for site reclamation.

HLA recommends that the UST identified at the site be closed in accordance with ADEQ regulations discussed in Section 3.3. Approximate closure costs would be $10,500 as detailed in Table D-1 in Appendix D.

6.0 REFERENCES

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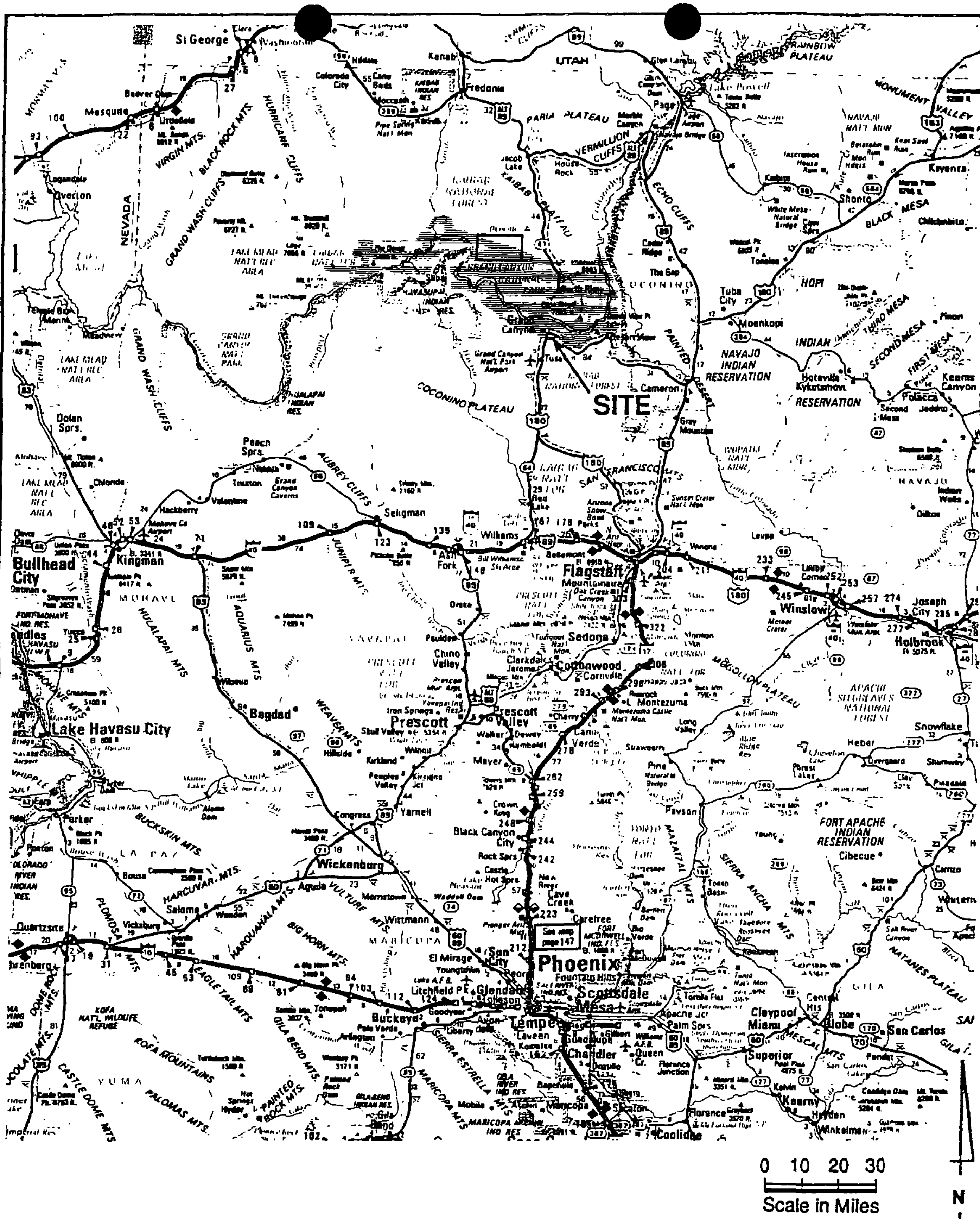

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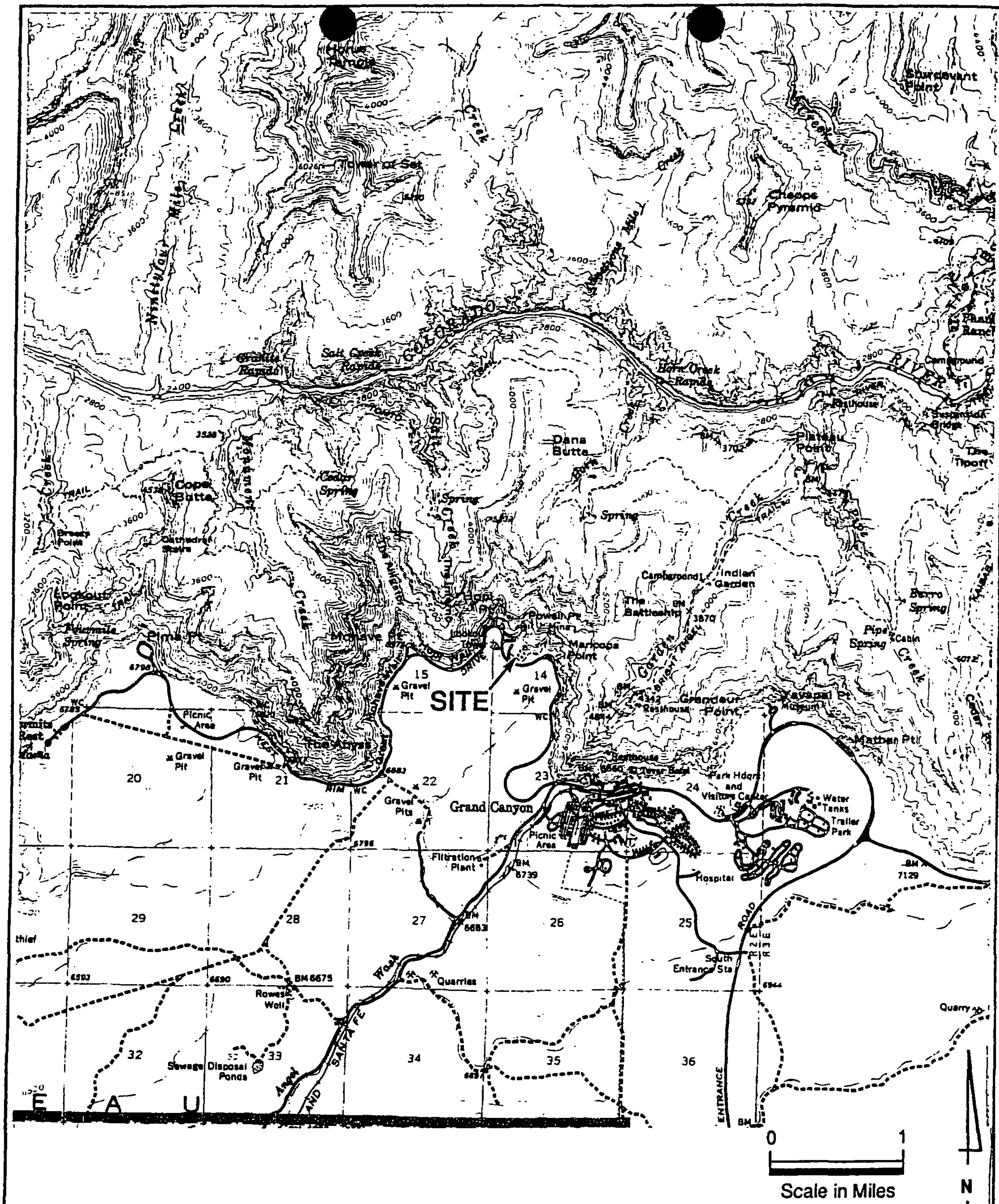
Harding Lawson Associates
Engineering and Environmental Services

Site Vicinity Map
Orphan Mine
Grand Canyon National Park, Arizona

PLATE
1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
AM	22040-002	[signature]	12/92	



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Harding Lawson Associates
Engineering and
Environmental Services

Site Location Map
Orphan Mine
Grand Canyon National Park, Arizona

PLATE
2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
AM	22040-002	JR	12/92	

APPENDIX A

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT FORM

OMB Approval Number: 2050-0095
Approved for Use Through: 1/92

EPA Potential Hazardous Waste Site Preliminary Assessment Form

Identification

State: AZ | CERCLIS Number:

CERCLIS Discovery Date:

1. General Site Information

Name: NPS Orphan Mine	Street Address: 1½ miles northwest of South Rim Village
City: Grand Canyon National Park	State: AZ; Zip Code: ; County: Coconino; Co. Code: ; Cong. Dist:
Latitude: ___° ___' ___.___" Longitude: ___° ___' ___.___"	Approximate Area of Site: 3 Acres; ___ Square Ft

Status of Site: ☐ Active ☐ Not Specified ☒ Inactive ☐ NA (GW plume, etc.)

2. Owner/Operator Information

Owner: National Park Service (NPS)	Operator: Inactive
Street Address: Denver Services Center, 12795 W. Alameda Parkway, P.O. Box 25287	Street Address: NA
City: Denver	City: NA
State: CO; Zip Code: 80225; Telephone: (303) 969-2220	State: NA; Zip Code: NA; Telephone: NA ( )

Type of Ownership:
- ☐ Private
- ☒ Federal Agency Name: NPS
- ☐ State
- ☐ Indian
- ☐ County
- ☐ Municipal
- ☐ Not Specified
- ☐ Other ________

How Initially Identified:
- ☐ Citizen Complaint
- ☐ PA Petition
- ☐ State/Local Program
- ☐ RCRA/CERCLA Notification
- ☒ Federal Program
- ☐ Incidental
- ☐ Not Specified
- ☐ Other ________

3. Site Evaluator Information

Name of Evaluator:	Agency/Organization: Harding Lawson Associates	Date Prepared: April 1993
Street Address: 2400 ARCO Tower, 707 Seventeenth Street	City: Denver	State: CO
Name of EPA or State Agency Contact:	Street Address:	
City:	State:	Telephone: ( )

4. Site Disposition (for EPA use only)

Emergency Response/Removal Assessment Recommendation:
- ☐ Yes
- ☐ No
- Date: ________

CERCLIS Recommendation:
- ☐ Higher Priority SI
- ☐ Lower Priority SI
- ☐ NFRAP
- ☐ RCRA
- ☐ Other ________
- Date: ________

Signature:

Name (typed):

Position:

EPA Potential Hazardous Waste Site
Preliminary Assessment Form - Page 2 of 4

CERCLIS Number:

5. General Site Characteristics

Predominant Land Uses Within 1 Mile of Site (check all that apply):
- [ ] Industrial
- [ ] Commercial
- [ ] Residential
- [ ] Forest/Fields
- [ ] Agriculture
- [ ] Mining
- [ ] DOD
- [ ] DOE
- [ ] DOI
- [x] Other Federal Facility National Park
- [ ] Other ______

Site Setting:
- [ ] Urban
- [ ] Suburban
- [x] Rural

Years of Operation:
Beginning Year 1906
Ending Year 1969
- [ ] Unknown

Type of Site Operations (check all that apply):
- [ ] Manufacturing (must check subcategory)
  - [ ] Lumber and Wood Products
  - [ ] Inorganic Chemicals
  - [ ] Plastic and/or Rubber Products
  - [ ] Paints, Varnishes
  - [ ] Industrial Organic Chemicals
  - [ ] Agricultural Chemicals (e.g., pesticides, fertilizers)
  - [ ] Miscellaneous Chemical Products (e.g., adhesives, explosives, ink)
  - [ ] Primary Metals
  - [ ] Metal Coating, Plating, Engraving
  - [ ] Metal Forging, Stamping
  - [ ] Fabricated Structural Metal Products
  - [ ] Electronic Equipment
  - [ ] Other Manufacturing
- [x] Mining
  - [x] Metals
  - [ ] Coal
  - [ ] Oil and Gas
  - [ ] Non-metallic Minerals
- [ ] Retail
- [ ] Recycling
- [ ] Junk/Salvage Yard
- [ ] Municipal Landfill
- [ ] Other Landfill ______
- [ ] DOD
- [ ] DOE
- [ ] DOI
- [ ] Other Federal Facility ______
- [ ] RCRA
  - [ ] Treatment, Storage, or Disposal
  - [ ] Large Quantity Generator
  - [ ] Small Quantity Generator
  - [ ] Subtitle D
    - [ ] Municipal
    - [ ] Industrial
  - [ ] "Converter"
  - [ ] "Protective Filer"
  - [ ] "Non- or Late Filer"
- [ ] Not Specified
- [ ] Other ______

Waste Generated:
- [x] Onsite
- [ ] Offsite
- [ ] Onsite and Offsite

Waste Deposition Authorized By:
- [ ] Present Owner
- [x] Former Owner
- [ ] Present & Former Owner
- [ ] Unauthorized
- [ ] Unknown

Waste Accessible to the Public:
- [x] Yes
- [ ] No

Distance to Nearest Dwelling, School, or Workplace:
2-3 miles ~~Feet~~

6. Waste Characteristics Information

Source Type: (check all that apply)	Source Waste Quantity: (include units)	Tier*:
[ ] Landfill		
[ ] Surface Impoundment		
[ ] Drums		
[x] Tanks and Non-Drum Containers		✓
[ ] Chemical Waste Pile		
[ ] Scrap Metal or Junk Pile		
[ ] Tailings Pile		
[ ] Trash Pile (open dump)		
[ ] Land Treatment		
[ ] Contaminated Ground Water Plume (unidentified source)		
[ ] Contaminated Surface Water/Sediment (unidentified source)		
[x] Contaminated Soil		A
[ ] Other ______		
[ ] No Sources		

* C = Constituent, W = Wastestream, V = Volume, A = Area

General Types of Waste (check all that apply)
- [x] Metals
- [ ] Organics
- [ ] Inorganics
- [ ] Solvents
- [ ] Paints/Pigments
- [ ] Laboratory/Hospital Waste
- [x] Radioactive Waste
- [ ] Construction/Demolition Waste
- [ ] Pesticides/Herbicides
- [ ] Acids/Bases
- [ ] Oily Waste
- [ ] Municipal Waste
- [x] Mining Waste
- [ ] Explosives
- [ ] Other ______

Physical State of Waste as Deposited (check all that apply):
- [x] Solid
- [ ] Sludge
- [ ] Powder
- [ ] Liquid
- [ ] Gas

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CERCLIS Number:

7. Ground Water Pathway

Is Ground Water Used for Drinking Water Within 4 Miles:
- ☐ Yes
- ☒ No

Type of Drinking Water Wells Within 4 Miles (check all that apply):
- ☐ Municipal
- ☐ Private
- ☒ None

Is There a Suspected Release to Ground Water:
- ☐ Yes
- ☒ No

Have Primary Target Drinking Water Wells Been Identified:
- ☐ Yes
- ☒ No

If Yes, Enter Primary Target Population: ________ People

List Secondary Target Population Served by Ground Water Withdrawn From:

0 - ¼ Mile	
> ¼ - ½ Mile	
> ½ - 1 Mile	
> 1 - 2 Miles	
> 2 - 3 Miles	
> 3 - 4 Miles	
Total Within 4 Miles	0

Depth to Shallowest Aquifer: 1000 Feet

Karst Terrain/Aquifer Present:
- ☐ Yes
- ☒ No

Nearest Designated Wellhead Protection Area:
- ☐ Underlies Site
- ☐ >0 - 4 Miles
- ☒ None Within 4 Miles

8. Surface Water Pathway

Type of Surface Water Draining Site and 15 Miles Downstream (check all that apply):
☒ Stream ☒ River ☐ Pond ☐ Lake
☐ Bay ☐ Ocean ☐ Other ________

Shortest Overland Distance From Any Source to Surface Water:
________ Feet
1/2 Miles to head of Horn Creek

Is There a Suspected Release to Surface Water:
- ☐ Yes
- ☒ No

Site is Located in:
- ☐ Annual - 10 yr Floodplain
- ☐ > 10 yr - 100 yr Floodplain
- ☐ > 100 yr - 500 yr Floodplain
- ☒ > 500 yr Floodplain

Drinking Water Intakes Located Along the Surface Water Migration Path:
- ☐ Yes
- ☒ No

Have Primary Target Drinking Water Intakes Been Identified:
- ☐ Yes
- ☒ No

If Yes, Enter Population Served by Primary Target Intakes:
________ People

List All Secondary Target Drinking Water Intakes:

Name	Water Body	Flow (cfs)	Population Served
NA			

Total within 15 Miles: None

Fisheries Located Along the Surface Water Migration Path:
- ☐ Yes
- ☒ No

Have Primary Target Fisheries Been Identified:
- ☐ Yes
- ☒ No

List All Secondary Target Fisheries:

Water Body/Fishery Name	Flow (cfs)
Colorado River	7,000-20,000

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8. Surface Water Pathway (continued)

Wetlands Located Along the Surface Water Migration Path:
☐ Yes
☒ No

Have Primary Target Wetlands Been Identified:
☐ Yes
☒ No

List Secondary Target Wetlands:

Water Body	Flow (cfs)	Frontage Miles
None		

Other Sensitive Environments Located Along the Surface Water Migration Path:
☒ Yes
☐ No

Have Primary Target Sensitive Environments Been Identified:
☐ Yes
☒ No

List Secondary Target Sensitive Environments:

Water Body	Flow (cfs)	Sensitive Environment Type
Horn Creek	<10	National Park

9. Soil Exposure Pathway

Are People Occupying Residences or Attending School or Daycare on or Within 200 Feet of Areas of Known or Suspected Contamination:
☐ Yes
☒ No

If Yes, Enter Total Resident Population:
NA People

Number of Workers Onsite:
☒ None
☐ 1 - 100
☐ 101 - 1,000
☐ >1,000

Have Terrestrial Sensitive Environments Been Identified on or Within 200 Feet of Areas of Known or Suspected Contamination:
☐ Yes
☒ No

If Yes, List Each Terrestrial Sensitive Environment:
NA

10. Air Pathway

Is There a Suspected Release to Air:
☒ Yes
☐ No

Enter Total Population on or Within:

Onsite	0
0 - ¼ Mile	0
>¼ - ½ Mile	0
>½ - 1 Mile	0
>1 - 2 Miles	3400
>2 - 3 Miles	300
>3 - 4 Miles	0
Total Within 4 Miles	3700

Wetlands Located Within 4 Miles of the Site:
☐ Yes
☒ No

Other Sensitive Environments Located Within 4 Miles of the Site:
☒ Yes
☐ No

List All Sensitive Environments Within ½ Mile of the Site:

Distance	Sensitive Environment Type/Wetlands Area (acres)
Onsite	National Park
0 - ¼ Mile	National Park
>¼ - ½ Mile	National Park

APPENDIX B

PRELIMINARY ASSESSMENT SCORESHEETS

APPENDIX A

OMB Approval Number: 2050-0095
Approved for Use Through: 1/92

PA Scoresheets

Site Name: NPS Orphan Mine

CERCLIS ID No.: ______

Street Address: 1½ miles NW of South Rim Village

City/State/Zip: Grand Canyon National Park, AZ

Investigator: ______

Agency/Organization: National Park Service Denver Services Center

Street Address: 12795 W. Alameda Parkw

City/State/Zip: Denver, CO 80225

Date: 4/1993

GENERAL INFORMATION

Site Description and Operational History:

- 3 acre uranium mine including upper mine area and lower mine area
- inactive
- date of operation: 1906 - 1969

See Text for additional information

Probable Substances of Concern:
(Previous investigations, analytical data)

Radionuclides
Heavy metals
Diesel fuel

Site Sketch:
(Show all pertinent features, indicate sources and closest targets, indicate north)

SOURCE EVALUATION

Source No.: 1	Source Name: Potentially Contaminated Soil	Source Waste Quantity (WQ) Calculations:
Source Description: Conservatively assume the entire site area is contaminated as described below: Upper Mine Area Inside fence = 3 acres Outside fence = 1 acre Lower Mine Area = 2 acres 6 acres		Tier: Area 6 acres ÷ 0.78 = 7.69

Source No.: 2	Source Name: Underground Storage Tank	Source Waste Quantity (WQ) Calculations:
Source Description: Dimensions of UST are 5 ft wide × 13 ft long × unknown height. Assume tank volume = 5,000 gal		Tier: Volume 5,000 gal ÷ 500 = 10

Source No.: 3	Source Name: Possible Second UST	Source Waste Quantity (WQ) Calculations:
Source Description: Assume tank volume = 5000 gal		Tier: Volume 5,000 gal ÷ 500 = 10

7.69 + 10 + 10 = 27.69 = WC Total
WC Score = 18
(see PA Table 1b)

Site WC: 18

PA TABLE 1: WASTE CHARACTERISTICS (WC) SCORES

PA Table 1a: WC Scores for Single Source Sites and Formulas for Multiple Source Sites

TIER	SOURCE TYPE	SINGLE SOURCE SITES (assigned WC scores): WC = 18	WC = 32	WC = 100	MULTIPLE SOURCE SITES: Formula for Assigning Source WQ Values
[illegible]	N/A	≤100 lb	>100 to 10,000 lb	>10,000 lb	lb ÷ 1
WASTESTREAM	N/A	≤500,000 lb	>500,000 to 50 million lb	>50 million lb	lb ÷ 5,000
VOLUME	Landfill	≤6.75 million ft³ ≤250,000 yd³	>6.75 million to 675 million ft³ >250,000 to 25 million yd³	>675 million ft³ >25 million yd³	ft³ ÷ 67,500 yd³ ÷ 2,500
	Surface impoundment	≤6,750 ft³ ≤250 yd³	>6,750 to 675,000 ft³ >250 to 25,000 yd³	>675,000 ft³ >25,000 yd³	ft³ ÷ 67.5 yd³ ÷ 2.5
	Drums	≤1,000 drums	>1,000 to 100,000 drums	>100,000 drums	drums ÷ 10
	Tanks and non-drum containers	≤50,000 gallons	>50,000 to 5 million gallons	>5 million gallons	gallons ÷ 500
	Contaminated soil	≤6.75 million ft³ ≤250,000 yd³	>6.75 million to 675 million ft³ >250,000 to 25 million yd³	>675 million ft³ >25 million yd³	ft³ ÷ 67,500 yd³ ÷ 2,500
	Pile	≤6,750 ft³ ≤250 yd³	>6,750 to 675,000 ft³ >250 to 25,000 yd³	>675,000 ft³ >25,000 yd³	ft³ ÷ 67.5 yd³ ÷ 2.5
	Other	≤6,750 ft³ ≤250 yd³	>6,750 to 675,000 ft³ >250 to 25,000 yd³	>675,000 ft³ >25,000 yd³	ft³ ÷ 67.5 yd³ ÷ 2.5
AREA	Landfill	≤340,000 ft² ≤7.8 acres	>340,000 to 34 million ft² >7.8 to 780 acres	>34 million ft² >780 acres	ft² ÷ 3,400 acres ÷ 0.078
	Surface impoundment	≤1,300 ft² ≤0.029 acres	>1,300 to 130,000 ft² >0.029 to 2.9 acres	>130,000 ft² >2.9 acres	ft² ÷ 13 acres ÷ 0.00029
	Contaminated soil	≤3.4 million ft² ≤78 acres	>3.4 million to 340 million ft² >78 to 7,800 acres	>340 million ft² >7,800 acres	ft² ÷ 34,000 acres ÷ 0.78
	Pile*	≤1,300 ft² ≤0.029 acres	>1,300 to 130,000 ft² >0.029 to 2.9 acres	>130,000 ft² >2.9 acres	ft² ÷ 13 acres ÷ 0.00029
	Land treatment	≤27,000 ft² ≤0.62 acres	>27,000 to 2.7 million ft² >0.62 to 62 acres	>2.7 million ft² >62 acres	ft² ÷ 270 acres ÷ 0.0062

¹ ton = 2,000 lb = 1 yd³ = 4 drums = 200 gallons

* Use area of land surface under pile, not surface area of pile.

PA Table 1b: WC Scores for Multiple Source Sites

WQ Total	WC Score
>0 to 100	18
>100 to 10,000	32
>10,000	100

GROUND WATER PATHWAY
GROUND WATER USE DESCRIPTION

Describe Ground Water Use Within 4-miles of the Site:
(Describe stratigraphy, information on aquifers, municipal and/or private wells)

None

Calculations for Drinking Water Populations Served by Ground Water:

NA

GROUND WATER PATHWAY CRITERIA LIST

SUSPECTED RELEASE

Yes	No	Unk	
X			Are sources poorly contained?
	X		Is the source a type likely to contribute to ground water contamination (e.g., wet lagoon)?
	X		Is waste quantity particularly large?
	X		Is precipitation heavy?
	X		Is the infiltration rate high?
	X		Is the site located in an area of karst terrain?
	X		Is the subsurface highly permeable or conductive?
	X		Is drinking water drawn from a shallow aquifer?
	X		Are suspected contaminants highly mobile in ground water?
	X		Does analytical or circumstantial evidence suggest ground water contamination?
			Other criteria? ______________
	X		**SUSPECTED RELEASE?**

Summarize the rationale for Suspected Release (attach an additional page if necessary):

No suspected release to groundwater.

PRIMARY TARGETS

Yes	No	Unk	
	X		Is any drinking water well nearby?
	X		Has any nearby drinking water well been closed?
	X		Has any nearby drinking water user reported foul-tasting or foul-smelling water?
	X		Does any nearby well have a large drawdown or high production rate?
	X		Is any drinking water well located between the site and other wells that are suspected to be exposed to a hazardous substance?
	X		Does analytical or circumstantial evidence suggest contamination at a drinking water well?
	X		Does any drinking water well warrant sampling?
			Other criteria? ______________
	X		**PRIMARY TARGET(S) IDENTIFIED?**

Summarize the rationale for Primary Targets (attach an additional page if necessary):

No primary targets.

Groundwater pathway was not scored because there are no active wells within 4 miles of the site.

GROUND WATER PATHWAY SCORESHEET

Pathway Characteristics

Do you suspect a release (see Ground Water Pathway Criteria List, page 7)?	Yes ___ No X
Is the site located in karst terrain?	Yes ___ No X
Depth to aquifer:	1000 ft
Distance to the nearest drinking water well:	24 miles

	A Suspected Release	B No Suspected Release	References
LIKELIHOOD OF RELEASE			
1. SUSPECTED RELEASE: If you suspect a release to ground water (see page 7), assign a score of 550. Use only column A for this pathway.	(550)		
2. NO SUSPECTED RELEASE: If you do not suspect a release to ground water, and the site is in karst terrain or the depth to aquifer is 70 feet or less, assign a score of 500; otherwise, assign a score of 340. Use only column B for this pathway.		(500 or 340)	
LR =			
TARGETS			
3. PRIMARY TARGET POPULATION: Determine the number of people served by drinking water wells that you suspect have been exposed to a hazardous substance from the site (see Ground Water Pathway Criteria List, page 7). ___ people x 10 =			
4. SECONDARY TARGET POPULATION: Determine the number of people served by drinking water wells that you do NOT suspect have been exposed to a hazardous substance from the site, and assign the total population score from PA Table 2. Are any wells part of a blended system? Yes ___ No ___ If yes, attach a page to show apportionment calculations.			
5. NEAREST WELL: If you have identified a primary target population for ground water, assign a score of 50; otherwise, assign the Nearest Well score from PA Table 2. If no drinking water wells exist within 4 miles, assign a score of zero.	(50 maximum)	(50 maximum)	
6. WELLHEAD PROTECTION AREA (WHPA): If any source lies within or above a WHPA, or if you have identified any primary target well within a WHPA, assign a score of 20; assign 5 if neither condition holds but a WHPA is present within 4 miles; otherwise assign zero.	(20, 5, or 0)	(20, 5, or 0)	
7. RESOURCES	(5 or 0)	(5 or 0)	
T =			
WASTE CHARACTERISTICS			
8. A. If you have identified any primary target for ground water, assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor.	(100 or 32)		
B. If you have NOT identified any primary target for ground water, assign the waste characteristics score calculated on page 4.	(100, 32, or 18)	(100, 32, or 18)	
WC =			

GROUND WATER PATHWAY SCORE: $\frac{LR \times T \times WC}{82{,}500}$ (subject to a maximum of 100) NA

PA TABLE 2: VALUES FOR SECONDARY GROUND WATER TARGET POPULATIONS

(N-1)

PA Table 2a: Non Karst Aquifers

Distance from Site	Population	Nearest Well (choose highest)	Population Served by Wells Within Distance Category: 1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	Greater than 100,000	Population Value
0 to ¼ mile	______	20	1	2	5	16	52	163	521	1,633	5,214	16,325	
> ¼ to ½ mile	______	18	1	1	3	10	32	101	323	1,012	3,233	10,121	______
> ½ to 1 mile	______	9	1	1	2	5	17	52	167	522	1,668	5,224	______
> 1 to 2 miles	______	5	1	1	1	3	9	29	94	294	939	2,938	
> 2 to 3 miles	______	3	1	1	1	2	7	21	68	212	678	2,122	______
> 3 to 4 miles	______	2	1	1	1	1	4	13	42	131	417	1,306	______
	Nearest Well =											Score =	

PA Table 2b: Karst Aquifers

Distance from Site	Population	Nearest Well (use 20 for karst)	Population Served by Wells Within Distance Category: 1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	Greater than 100,000	Population Value
0 to ¼ mile	______	20	1	2	5	16	52	163	521	1,633	5,214	16,325	______
> ¼ to ½ mile	______	20	1	1	3	10	32	101	323	1,012	3,233	10,121	______
> ½ to 1 mile	______	20	1	1	3	8	26	82	261	816	2,607	8,162	______
> 1 to 2 miles	______	20	1	1	3	8	26	82	261	816	2,607	8,162	
> 2 to 3 miles	______	20	1	1	3	8	26	82	261	816	2,607	8,162	______
> 3 to 4 miles	______	20	1	1	3	8	26	82	261	816	2,607	8,162	______
	Nearest Well =											Score =	

SURFACE WATER PATHWAY
MIGRATION ROUTE SKETCH

Suface Water Migration Route Sketch:
(include runoff route, probable point of entry, 15-mile target distance limit, intakes, fisheries, and sensitive environments)

SURFACE WATER PATHWAY CRITERIA LIST

SUSPECTED RELEASE

Yes	No	Unk	
	X		Is surface water nearby?
	X		Is waste quantity particularly large?
X			Is the drainage area large?
	X		Is rainfall heavy?
X			Is the infiltration rate low?
X			Are sources poorly contained or prone to runoff or flooding?
	X		Is a runoff route well defined (e.g., ditch or channel leading to surface water)?
	X		Is vegetation stressed along the probable run-off route?
	X		Are sediments or water unnaturally discolored?
	X		Is wildlife unnaturally absent?
	X		Has deposition of waste into surface water been observed?
X			Is ground water discharge to surface water likely?
	X		Does analytical or circumstantial evidence suggest surface water contamination?
			Other criteria? ______
			SUSPECTED RELEASE?

Summarize the rationale for Suspected Release (attach an additional page if necessary):

No suspected release to Surface water.

PRIMARY TARGETS

Yes	No	Unk	
X			Is any target nearby? If yes:
			☐ Drinking water intake ☐ Fishery ☒ Sensitive environment
	X		Has any intake, fishery, or recreational area been closed?
	X		Does analytical or circumstantial evidence suggest surface water contamination at or downstream of a target?
	X		Does any target warrant sampling? If yes:
			☐ Drinking water intake ☐ Fishery ☐ Sensitive environment
			Other criteria? ______
	X		**PRIMARY INTAKE(S) IDENTIFIED?**
	X		**PRIMARY FISHERY(IES) IDENTIFIED?**
	X		**PRIMARY SENSITIVE ENVIRONMENT(S) IDENTIFIED?**

Summarize the rationale for Primary Targets (attach an additional page if necessary):

No suspected release to surface water; therefore no primary targets. The site is within a national park which is considered a sensitive environment for scoring purposes.

Surface water pathway drinking water threat was not scored because no drinking water intakes l[illegible]t within 15 downstream mi[illegible] of the site.

SURFACE WATER PATHWAY
LIKELIHOOD OF RELEASE AND DRINKING WATER THREAT SCORESHEET

Pathway Characteristics

Do you suspect a release (see Surface Water Pathway Criteria List, page 11)? Yes ___ No X
Distance to surface water: 2640
Flood frequency: >500 yrs
What is the downstream distance to the nearest drinking water intake? >15 miles
Nearest fishery? 2 miles Nearest sensitive environment? 1/2 miles

LIKELIHOOD OF RELEASE	A Suspected Release	B No Suspected Release	References
1. SUSPECTED RELEASE: If you suspect a release to surface water (see page 11), assign a score of 550. Use only column A for this pathway.			
2. NO SUSPECTED RELEASE: If you do not suspect a release to surface water, use the table below to assign a score based on distance to surface water and flood frequency. Use only column B for this pathway.			
LR =			

Distance to surface water ≤ 2,500 feet	500
Distance to surface water > 2,500 feet, and	
Site in annual or 10-year floodplain	500
Site in 100-year floodplain	400
Site in 500-year floodplain	300
Site outside 500-year floodplain	100

DRINKING WATER THREAT TARGETS	A	B	References
3. Record the water body type, flow (if applicable), and number of people served by each drinking water intake within the target distance limit. If there is no drinking water intake within the target distance limit, factors 4, 5, and 6 each receive zero scores.			
4. PRIMARY TARGET POPULATION: If you suspect any drinking water intake listed above has been exposed to a hazardous substance from the site (see Surface Water Pathway Criteria List, page 11), list the intake name(s) and calculate the factor score based on the total population served. ___ people x 10 =			
5. SECONDARY TARGET POPULATION: Determine the number of people served by drinking water intakes that you do NOT suspect have been exposed to a hazardous substance from the site, and assign the total population score from PA Table 3. Are any intakes part of a blended system? Yes ___ No ___ If yes, attach a page to show apportionment calculations.			
6. NEAREST INTAKE: If you have identified a primary target population for the drinking water threat (factor 4), assign a score of 50; otherwise, assign the Nearest Intake score from PA Table 3. If no drinking water intake exists within the target distance limit, assign a score of zero.			
7. RESOURCES			
T =			

Intake Name	Water Body Type	Flow	People Served
		cfs	
		cfs	
		cfs	

PA TABLE 3: VALUES FOR SECONDARY SURFACE WATER TARGET POPULATIONS

(N/A)

Surface Water Body Flow (see PA Table 4)	Population	Nearest Intake (choose highest)	Population Served by Intakes Within Flow Category: 1 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	100,001 to 300,000	300,001 to 1,000,000	Greater than 1,000,000	Population Value
< 10 cfs	_____	20	2	5	16	52	163	521	1,633	5,214	16,325	52,136	163,246	_____
10 to 100 cfs	_____	2	1	1	2	5	16	52	163	521	1,633	5,214	16,325	_____
> 100 to 1,000 cfs	_____	1	0	0	1	1	2	5	16	52	163	521	1,633	_____
> 1,000 to 10,000 cfs	_____	0	0	0	0	0	1	1	2	5	16	52	163	_____
> 10,000 cfs or Great Lakes	_____	0	0	0	0	0	0	0	1	1	2	5	16	_____
3 mile Mixing Zone	_____	10	1	3	8	26	82	261	816	2,607	8,162	26,068	81,663	_____

Nearest Intake = _____ Score = _____

PA TABLE 4: SURFACE WATER TYPE / FLOW CHARACTERISTICS WITH DILUTION WEIGHTS FOR SECONDARY SURFACE WATER SENSITIVE ENVIRONMENTS

Type of Surface Water Body: Water Body Type	OR Flow	Dilution Weight
minimal stream	< 10 cfs	1
small to moderate stream	10 to 100 cfs	0.1
moderate to large stream	> 100 to 1,000 cfs	N/A
large stream to river	> 1,000 to 10,000 cfs	N/A
large river	> 10,000 cfs	N/A
3 mile mixing zone of quiet flowing streams or rivers	10 cfs or greater	N/A
coastal tidal water (harbors, sounds, bays, etc.), ocean, or Great Lakes	N/A	N/A

SURFACE WATER PATHWAY (continued)
HUMAN FOOD CHAIN THREAT SCORESHEET

LIKELIHOOD OF RELEASE		A Suspected Release	B No Suspected Release	References
Enter Surface Water Likelihood of Release score from page 12.	LR =		100	

HUMAN FOOD CHAIN THREAT TARGETS

8. Record the water body type and flow (if applicable) for each fishery within the target distance limit. If there is no fishery within the target distance limit, assign a Targets score of 0 at the bottom of the page.

Fishery Name	Water Body Type	Flow
Colorado River	River	7000 - 20,000 cfs
		cfs
		cfs
		cfs
		cfs

9. PRIMARY FISHERIES: If you suspect any fishery listed above has been exposed to a hazardous substance from the site (see Surface Water Criteria List, page 111), assign a score of 300 and do not evaluate Factor 10. List the primary fisheries:

A	B	References
—		

10. SECONDARY FISHERIES

A. If you suspect a release to surface water and have identified a secondary fishery but no primary fishery, assign a score of 210.

A	B	References
—		

B. If you do not suspect a release, assign a Secondary Fisheries score from the table below using the lowest flow at any fishery within the target distance limit.

Lowest Flow	Secondary Fisheries Score
< 10 cfs	210
10 to 100 cfs	30
> 100 cfs, coastal tidal waters, oceans, or Great Lakes	12

A	B	References
	12	

	A	B
T =		12

SURFACE WATER PATHWAY (continued)
ENVIRONMENTAL THREAT SCORESHEET

LIKELIHOOD OF RELEASE		A Suspected Release	B No Suspected Release	References
Enter Surface Water Likelihood of Release score from page 12.	LR =		100	

ENVIRONMENTAL THREAT TARGETS

11. Record the water body type and flow (if applicable) for each surface water sensitive environment within the target distance limit (see PA Tables 4 and 5). If there is no sensitive environment within the target distance limit, assign a Targets score of 0 at the bottom of the page.

Environment Name	Water Body Type	Flow
National Park - Horn Creek	Intermittent Stream	< 10 cfs
National Park - Colorado River	River > 7,000 -	20,000 cfs
		cfs
		cfs
		cfs

12. PRIMARY SENSITIVE ENVIRONMENTS: If you suspect any sensitive environment listed above has been exposed to a hazardous substance from the site (see Surface Water Criteria List, page 11), assign a score of 300 and do not evaluate factor 13. List the primary sensitive environments:

13. SECONDARY SENSITIVE ENVIRONMENTS: If sensitive environments are present, but none is a primary sensitive environment, evaluate Secondary Sensitive Environments based on flow.

A. For secondary sensitive environments on surface water bodies with flows of 100 cfs or less, assign scores as follows, and do not evaluate part B of this factor:

Flow		Dilution Weight (PA Table 4)		Environment Type and Value (PA Tables 5 and 6)			Total
< 10	cfs	1	x	National Park	100	=	100
	cfs		x			=	
	cfs		x			=	
	cfs		x			=	
	cfs		x			=	

Sum = 100

B. If all secondary sensitive environments are located on surface water bodies with flows > 100 cfs, assign a score of 10. —

T = 100

PA TABLE 5: SURFACE WATER AND AIR PATHWAY SENSITIVE ENVIRONMENTS VALUES

Sensitive Environment	*Assigned Value*
Critical habitat for Federally designated endangered or threatened species Marine Sanctuary National Park Designated Federal Wilderness Area Ecologically important areas identified under the Coastal Zone Wilderness Act Sensitive Areas identified under the National Estuary Program or Near Coastal Water Program of the Clean Water Act Critical Areas identified under the Clean Lakes Program of the Clean Water Act (subareas in lakes or entire small lakes) National Monument (air pathway only) National Seashore Recreation Area National Lakeshore Recreation Area	100
Habitat known to be used by Federally designated or proposed endangered or threatened species National Preserve National or State Wildlife Refuge Unit of Coastal Barrier Resources System Federal land designated for the protection of natural ecosystems Administratively Proposed Federal Wilderness Area Spawning areas critical for the maintenance of fish/shellfish species within a river system, bay, or estuary Migratory pathways and feeding areas critical for the maintenance of anadromous fish species in a river system Terrestrial areas utilized for breeding by large or dense aggregations of vertebrate animals (air pathway) or semi-aquatic foragers (surface water pathway) National river reach designated as Recreational	75
Habitat known to be used by State designated endangered or threatened species Habitat known to be used by a species under review as to its Federal endangered or threatened status Coastal Barrier (partially developed) Federally designated Scenic or Wild River	50
State land designated for wildlife or game management State designated Scenic or Wild River State designated Natural Area Particular areas, relatively small in size, important to maintenance of unique biotic communities	25
State designated areas for protection/maintenance of aquatic life under the Clean Water Act	5
Wetlands	See PA Table 6 (Surface Water Pathway) or PA Table 9 (Air Pathway)

PA TABLE 6: SURFACE WATER PATHWAY WETLANDS FRONTAGE VALUES

Total Length of Wetlands	*Assigned Value*
Less than 0.1 mile	0
0.1 to 1 mile	25
Greater than 1 to 2 miles	50
Greater than 2 to 3 miles	75
Greater than 3 to 4 miles	100
Greater than 4 to 8 miles	150
Greater than 8 to 12 miles	250
Greater than 12 to 16 miles	350
Greater than 16 to 20 miles	450
Greater than 20 miles	500

SURFACE WATER PATHWAY (concluded)
WASTE CHARACTERISTICS, THREAT, AND PATHWAY SCORE SUMMARY

WASTE CHARACTERISTICS	A Suspected Release	B No Suspected Release
14. A. If you have identified any primary target for surface water (pages 12, 14, or 15), assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor.	[illegible]	
B. If you have NOT identified any primary target for surface water, assign the waste characteristics score calculated on page 4.	[illegible]	[illegible] 18
WC =		18

SURFACE WATER PATHWAY THREAT SCORES

Threat	Likelihood of Release (LR) Score (from page 12)	Targets (T) Score (pages 12, 14, 15)	Pathway Waste Characteristics (WC) Score (determined above)	Threat Score LR x T x WC / 82,500
Drinking Water	—	—	—	[illegible] —
Human Food Chain	100	12	18	[illegible] 0.26
Environmental	100	100	18	[illegible] 2.18

SURFACE WATER PATHWAY SCORE (Drinking Water Threat + Human Food Chain Threat + Environmental Threat)	[illegible] 2.44

SOIL EXPOSURE PATHWAY CRITERIA LIST

SUSPECTED CONTAMINATION	Yes	No	Unk	RESIDENT POPULATION
Surficial contamination can generally be assumed.	☐	☒	☐	Is any residence, school, or daycare facility on or within 200 feet of an area of suspected contamination?
	☐	☒	☐	Is any residence, school, or daycare facility located on adjacent land previously owned or leased by the site owner/operator?
	☐	☒	☐	Is there a migration route that might spread hazardous substances near residences, schools, or daycare facilities?
	☐	☒	☐	Have onsite or adjacent residents or students reported adverse health effects, exclusive of apparent drinking water or air contamination problems?
	☐	☒	☐	Does any neighboring property warrant sampling?
	☐	☐		Other criteria? ______
	☐	☐		RESIDENT POPULATION IDENTIFIED?

Summarize the rationale for Resident Population (attach an additional page if necessary):

No resident population identified.

SOIL EXPOSURE PATHWAY SCORESHEET

Pathway Characteristics

Do any people live on or within 200 ft of areas of suspected contamination? Yes ___ No X

Do any people attend school or daycare on or within 200 ft of areas of suspected contamination? Yes ___ No X

Is the facility active? Yes ___ No X If yes, estimate the number of workers: NA

	Suspected Contamination	References
LIKELIHOOD OF EXPOSURE		
1. SUSPECTED CONTAMINATION: Surficial contamination can generally be assumed, and a score of 550 assigned. Assign zero only if the absence of surficial contamination can be confidently demonstrated. LE =	550	
RESIDENT POPULATION THREAT TARGETS		
2. RESIDENT POPULATION: Determine the number of people occupying residences or attending school or daycare on or within 200 feet of areas of suspected contamination (see Soil Exposure Pathway Criteria List, page 18). 0 people x 10 =	0	
3. RESIDENT INDIVIDUAL: If you have identified a resident population (factor 2), assign a score of 50; otherwise, assign a score of 0.	0	
4. WORKERS: Use the following table to assign a score based on the total number of workers at the facility and nearby facilities with suspected contamination:	0	
5. TERRESTRIAL SENSITIVE ENVIRONMENTS: Use PA Table 7 to assign a value for each terrestrial sensitive environment on an area of suspected contamination: Sum =	100	
6. RESOURCES	5	
T =	105	
WASTE CHARACTERISTICS		
7. Assign the waste characteristics score calculated on page 4. WC =	18	

Number of Workers	Score
0	0
1 to 100	5
101 to 1,000	10
>1,000	15

Terrestrial Sensitive Environment Type	Value
National Park	100

RESIDENT POPULATION THREAT SCORE: $\frac{LE \times T \times WC}{82,500}$ = 12.60

NEARBY POPULATION THREAT SCORE: 1

SOIL EXPOSURE PATHWAY SCORE:
Resident Population Threat + Nearby Population Threat = 13.60

PA TABLE 7: SOIL EXPOSURE PATHWAY TERRESTRIAL SENSITIVE ENVIRONMENT VALUES

Terrestrial Sensitive Environment	Assigned Value
Terrestrial critical habitat for Federally designated endangered or threatened species National Park Designated Federal Wilderness Area National Monument	100
Terrestrial habitat known to be used by Federally designated or proposed threatened or endangered species National Preserve (terrestrial) National or State terrestrial Wildlife Refuge Federal land designated for protection of natural ecosystems Administratively proposed Federal Wilderness Area Terrestrial areas utilized by large or dense aggregations of animals (vertebrate species) for breeding	75
Terrestrial habitat used by State designated endangered or threatened species Terrestrial habitat used by species under review for Federal designated endangered or threatened status	50
State lands designated for wildlife or game management State designated Natural Areas Particular areas, relatively small in size, important to maintenance of unique biotic communities	25

AIR PATHWAY CRITERIA LIST

SUSPECTED RELEASE				PRIMARY TARGETS
Yes	No	Unk		
	X		Are odors currently reported?	
			Has release of a hazardous substance to the air been directly observed?	If you suspect a release to air, evaluate all populations and sensitive environments within 1/4 mile (including those onsite) as primary targets.
	X		Are there reports of adverse health effects (e.g., headaches, nausea, dizziness) potentially resulting from migration of hazardous substances through the air?	
X			Does analytical or circumstantial evidence suggest a release to the air?	
			Other criteria? ____________	
			SUSPECTED RELEASE?	

Summarize the rationale for Suspected Release (attach an additional page if necessary):

A suspected release to air is assigned on the basis of radionuclide survey results indicating gamma radiation levels elevated above background are present over portions of the site. The radionuclide survey was conducted during the sitevisit of November 4 and 5, 1992.

AIR PATHWAY SCORESHEET

Pathway Characteristics

Do you suspect a release (see Air Pathway Criteria List, page 21)? Yes X No ___

Distance to the nearest individual: 5280 - 10,560 ft

	A Suspected Release	B No Suspected Release	References
LIKELIHOOD OF RELEASE			
1. SUSPECTED RELEASE: If you suspect a release to air (see page 21), assign a score of 550. Use only column A for this pathway.	550		
2. NO SUSPECTED RELEASE: If you do not suspect a release to air, assign a score of 500. Use only column B for this pathway.			
LR =			
TARGETS			
3. PRIMARY TARGET POPULATION: Determine the number of people subject to exposure from a suspected release of hazardous substances to the air. 0 people x 10 =	0		
4. SECONDARY TARGET POPULATION: Determine the number of people not suspected to be exposed to a release to air, and assign the total population score using PA Table 8.	3		
5. NEAREST INDIVIDUAL: If you have identified any Primary Target Population for the air pathway, assign a score of 50; otherwise, assign the Nearest Individual score from PA Table 8.	0		
6. PRIMARY SENSITIVE ENVIRONMENTS: Sum the sensitive environment values (PA Table 5) and wetland acreage values (PA Table 9) for environments subject to exposure from a suspected release to the air. Sum =	100		
7. SECONDARY SENSITIVE ENVIRONMENTS. Use PA Table 10 to determine the score for secondary sensitive environments.	0.54		
8. RESOURCES	5		
T =	108.54		
WASTE CHARACTERISTICS			
9. A. If you have identified any Primary Target for the air pathway, assign the waste characteristics score calculated on page 4, or a score of 32, whichever is GREATER; do not evaluate part B of this factor.	32		
B. If you have NOT identified any Primary Target for the air pathway, assign the waste characteristics score calculated on page 4.	—		
WC =	32		

Sensitive Environment Type	Value
National Park	100

AIR PATHWAY SCORE: $\frac{LR \times T \times WC}{82,500}$ = 23.15

PA TABLE 8: VALUES FOR SECONDARY AIR TARGET POPULATIONS

Distance from Site	Population	Nearest Individual (choose highest)	Population Within Distance Category: 1 to 10	11 to 30	31 to 100	101 to 300	301 to 1,000	1,001 to 3,000	3,001 to 10,000	10,001 to 30,000	30,001 to 100,000	100,001 to 300,000	300,001 to 1,000,000	Greater than 1,000,000	Population Value
Onsite	0	20	1	2	5	16	52	163	521	1,633	5,214	16,325	52,136	163,246	—
>0 to ¼ mile	0	20	1	1	1	4	13	41	130	408	1,303	4,081	13,034	40,811	—
>¼ to ½ mile	0	2	0	0	1	1	3	9	28	88	282	882	2,816	8,815	—
>½ to 1 mile	0	1	0	0	0	1	1	3	8	26	83	261	834	2,612	—
>1 to 2 miles	3400[a]	0	0	0	0	0	1	1	3	8	27	83	266	833	3
>2 to 3 miles	300[b]	0	0	0	0	0	1	1	1	4	12	38	120	376	0
>3 to 4 miles	0	0	0	0	0	0	0	1	1	2	7	23	73	229	—

Nearest Individual = 0

Score = 3

PA TABLE 9: AIR PATHWAY VALUES FOR WETLAND AREA

Wetland Area	Assigned Value
Less than 1 acre	0
1 to 50 acres	25
Greater than 50 to 100 acres	75
Greater than 100 to 150 acres	125
Greater than 150 to 200 acres	175
Greater than 200 to 300 acres	250
Greater than 300 to 400 acres	350
Greater than 400 to 500 acres	450
Greater than 500 acres	500

PA TABLE 10: DISTANCE WEIGHTS AND CALCULATIONS FOR AIR PATHWAY SECONDARY SENSITIVE ENVIRONMENTS

Distance	Distance Weight	Sensitive Environment Type and Value (from PA Table 5 or 9)	Product
Onsite	0.10	×	
		×	
0 1/4 mi	0.025	×	
		×	
		×	
1/4 1/2mi	0.0054	× National Park 100 × .0054	0.54
		×	
		×	
		×	

Total Environments Score = 0.54

a 2000 residents + 300 students + 100 daycare students + estimated 1000 workers

b [illegible] workers

SITE SCORE CALCULATION

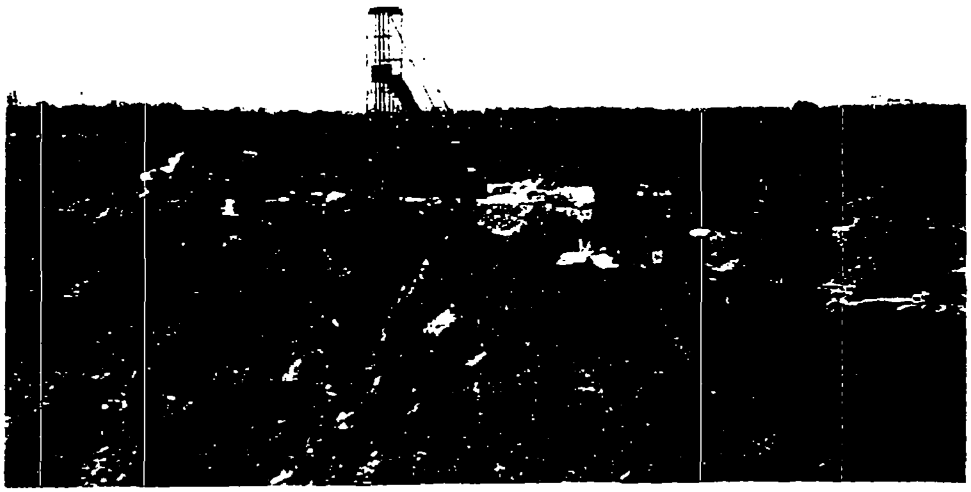
	S	S^2
GROUND WATER PATHWAY SCORE (S_{gw}):	—	—
SURFACE WATER PATHWAY SCORE (S_{sw}):	2.44	5.95
SOIL EXPOSURE PATHWAY SCORE (S_s):	13.60	184.96
AIR PATHWAY SCORE (S_a):	23.15	535.92
SITE SCORE:	$\sqrt{\frac{S_{gw}^2+S_{sw}^2+S_s^2+S_a^2}{4}}$	13.47

SUMMARY

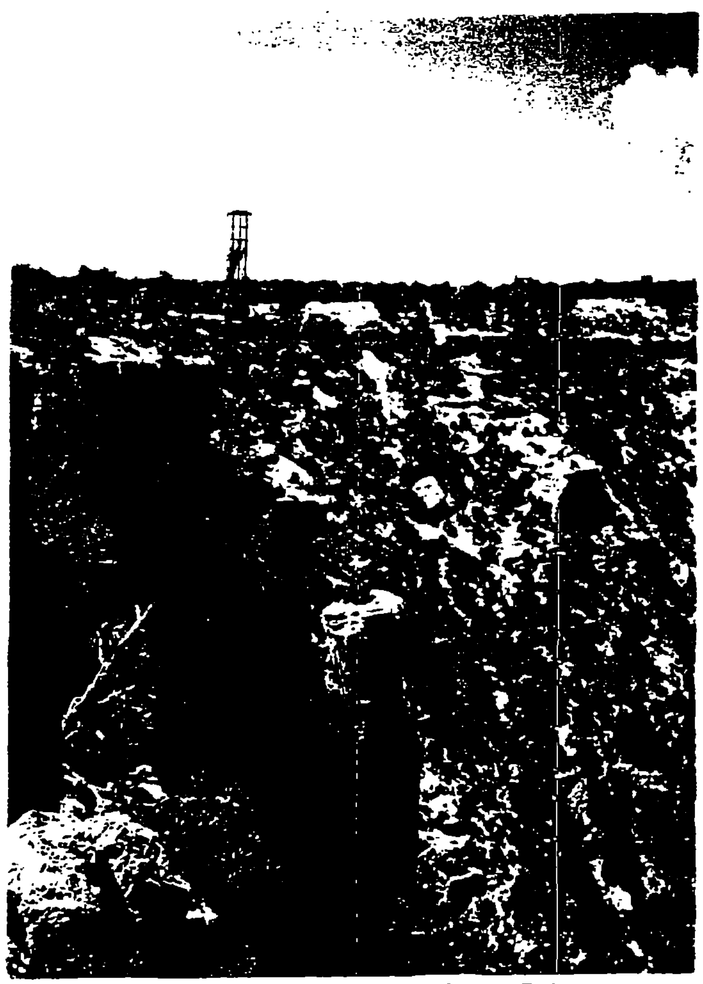
	YES	NO
1. Is there a high possibility of a threat to any nearby drinking water well(s) by migration of a hazardous substance in ground water?	☐	☒
A. If yes, identify the well(s). NA		
B. If yes, how many people are served by the threatened well(s)? N/A		
2. Is there a high possibility of a threat to any of the following by hazardous substance migration in surface water?		
A. Drinking water intake	☐	☒
B. Fishery	☐	☒
C. Sensitive environment (wetland, critical habitat, others)	☐	☒
D. If yes, identify the target(s). NA		
3. Is there a high possibility of an area of surficial contamination within 200 feet of any residence, school, or daycare facility?	☐	☒
If yes, identify the property(ies) and estimate the associated population(s). NA		
4. Are there public health concerns at this site that are not addressed by PA scoring considerations? If yes, explain: Yes - There is concern regarding potential impacts to park visitors.	☐	☐

APPENDIX C

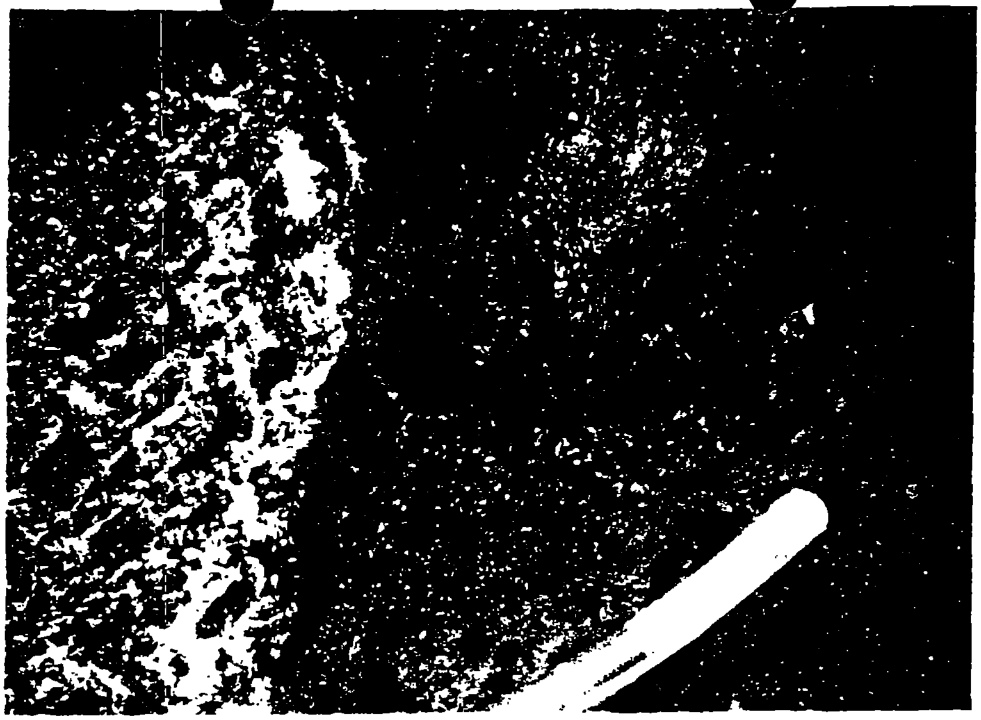
SITE PHOTOGRAPHS



South view of site from Hopi Point.

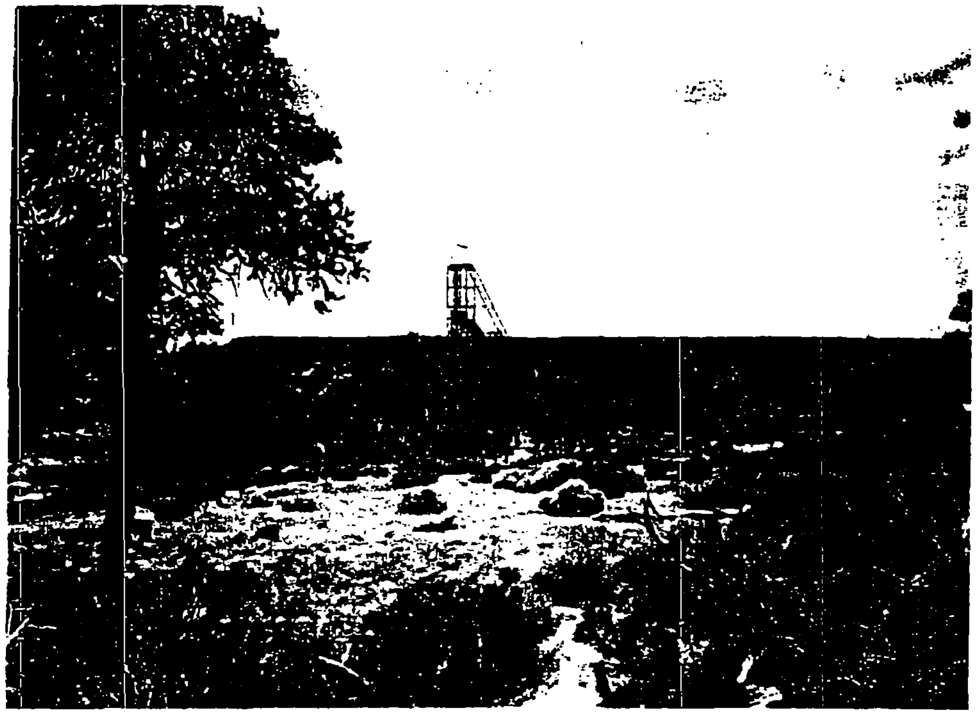


West view of site from Maricopa Point.



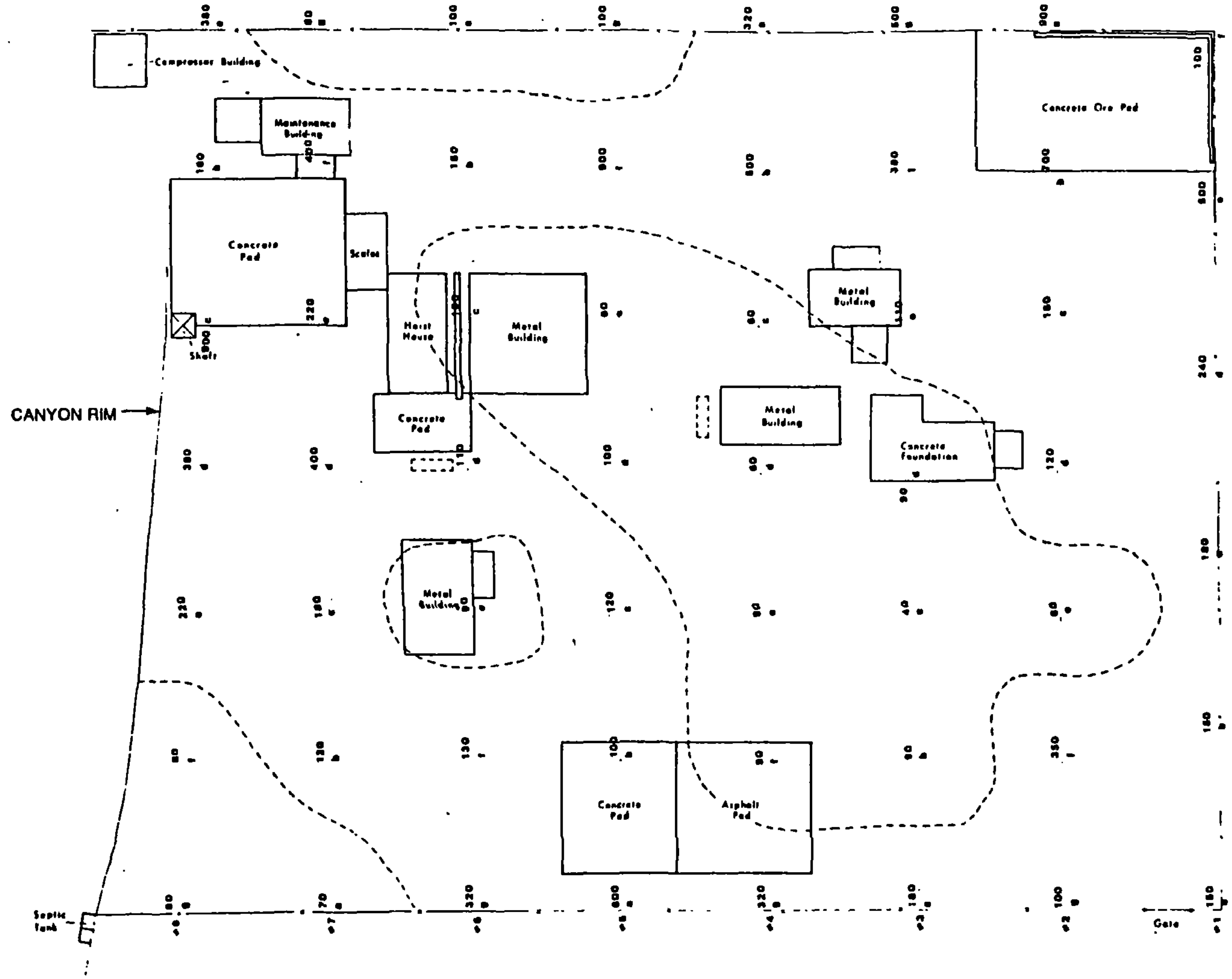
Aerial view of the "glory hole" at the lower mine area.

Aerial view of the "glory hole" and the lower mine area sheds.



Southeast view of area northwest of site with scattered tailings outside the site fenced area.

Northeast view of center of site with the main shaft headframe beyond.



0 40
Scale in Feet

Reference: Landmark Reclamation, 1986.

SURVEY NARRATIVE

Purpose

(1) To determine total gamma levels within the perimeter of the Orphan Mine Property.

(2) To get an indication of natural "background" of undisturbed surrounding area as a comparison.

Procedure

(1) An Eberline PRM-7 Micro R Meter was used.

(2) Calibrated last: 10-10-88 with a Cesium 137 source

(3) Instrument was carried at waist height.

(4) Readings were taken at approximate 60-foot intervals on transects 60 feet apart.

(5) Three soil samples were taken at sites within the perimeter of the area to develop an equilibrium factor for the disturbed area.

Two soil samples were taken outside of the perimeter area to develop an equilibrium factor for "near background" and "background" areas.

Samples were analyzed in-house for Total Natural Uranium analysis.

Sample Description

Sample #1 - Near point 6d with reading of 300 mR/hr.

Sample #2 - Taken at a point approximately 100 yards west of western perimeter fence and 80 feet east of BM 7054; - 7 mR/hr.

Sample #3a - 60 feet south - 75 feet east of gate to Orphan Mine yard. Top 6" of soil; 20 mR/hr

Sample #3b - Same location as 3a but at a 6" depth; 20 mR/hr.

Sample #4a - Near point 2g along western perimeter of yard fence. Sample taken at 0" - 4"; bedrock at 4". Reading of 100 mR/hr.

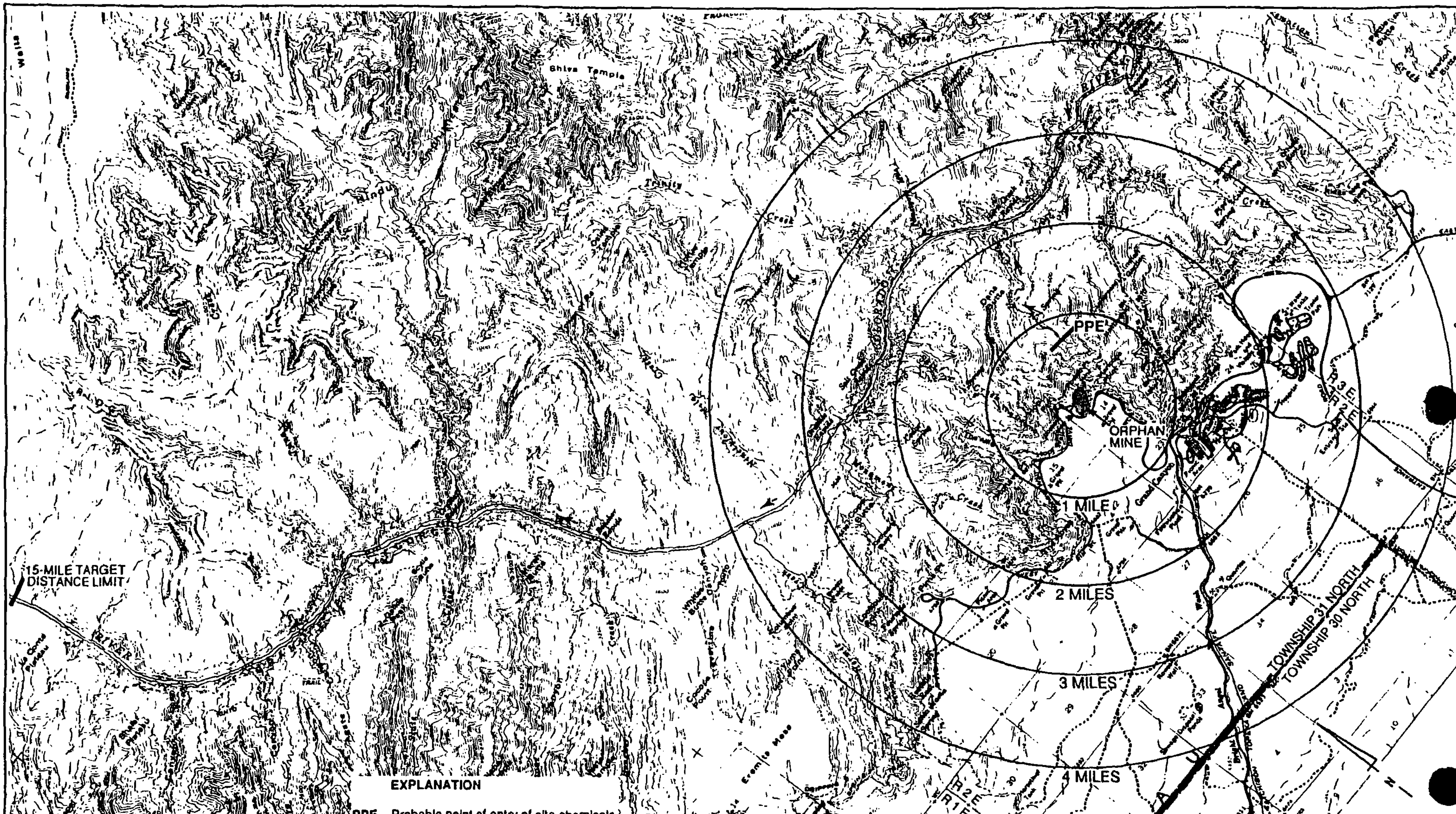
Sample #5a - Near point 3f just north of concrete pad. Top 6" with a reading of 300 mR/hr.

NOTES

UNITS: Total gamma radiation in mR/hr

---- Delineates areas with total gamma readings of 100 mR/hr, or less

Harding Lawson Associates Engineering and Environmental Services		**Site Plan** Orphan Mine Grand Canyon National Park, Arizona	PLATE 3
DRAWN AM	JOB NUMBER 22040-002	APPROVED JR	DATE 12/92	REVISED DATE



EXPLANATION

PPE Probable point of entry of site chemicals into a surface water body

→ Direction of surface water flow

0 1 Scale in Miles

Source: Grand Canyon National Park and Vicinity, Arizona, 1962 by U.S. Geological Survey.

HLA **Harding Lawson Associates** Engineering and Environmental Services

Potential Target Population Map
Orphan Mine
Grand Canyon National Park, Arizona

PLATE **4**

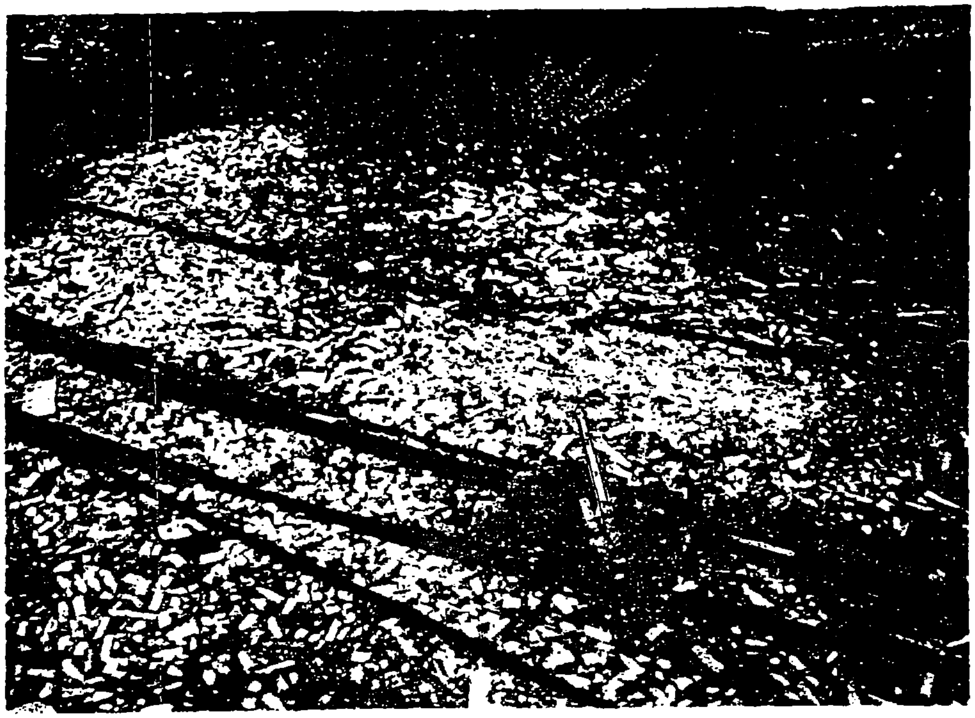
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
AM	22040-002	JR	4/93	

East view of tailings hopper at main shaft.

South view of concrete ore pad at south corner of site.

Southeast view of the main shaft headframe at the canyon rim.

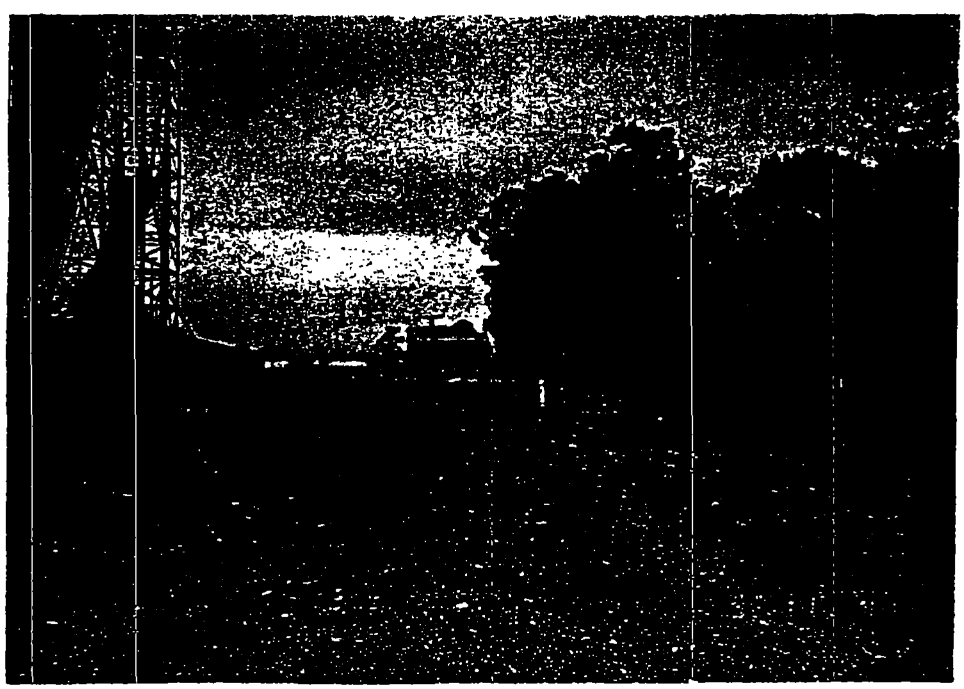
Southwest view of the southeast side of the site with the concrete ore pad beyond.



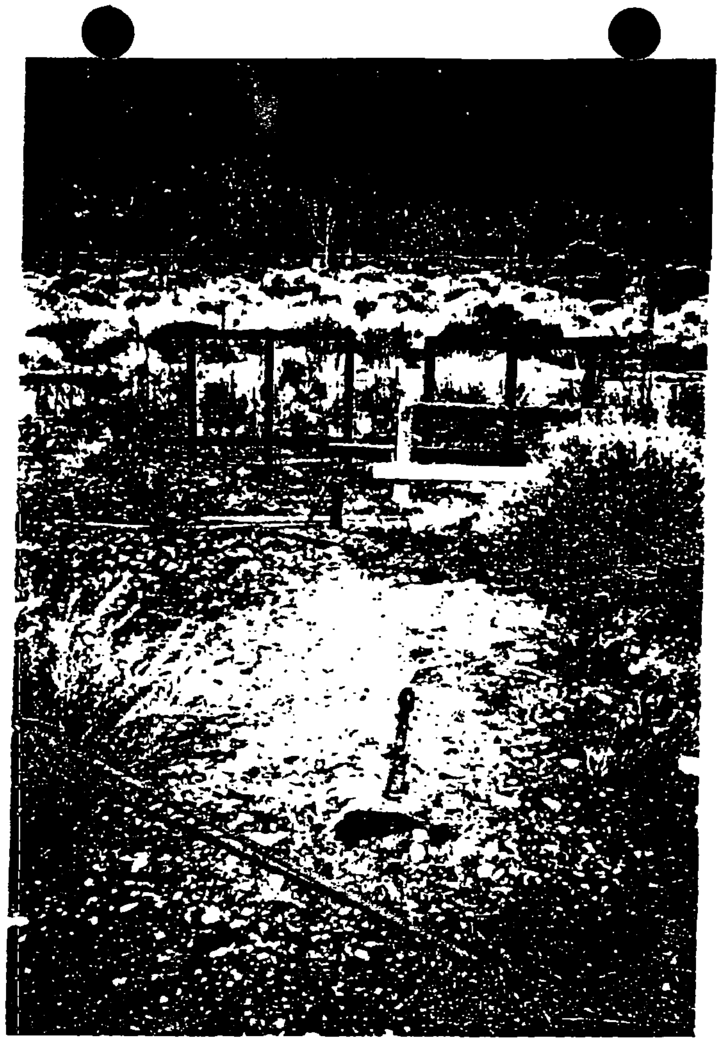
View of mine ore cores at site.

North view of area northwest of site with scattered mine tailings.
West corner of site at right.

Northeast view of northwest edge of site with the Canyon beyond.



Northeast view of the southeast side of site with scattered mine tailings on road.



Northwest view of the diesel underground storage tank fill spout covered with mine tailings. Northwest edge of site indicated by the fence beyond.

South view of diesel underground storage tank with west corner of site beyond.

APPENDIX D

SITE INVESTIGATION WORK PLAN

APPENDIX D
SITE INVESTIGATION WORK PLAN

The following discussion outlines the site investigation work plan. The work plan is divided into three tasks. Task 1 includes preliminary activities to be performed prior to the field investigation. Task 2 delineates the field sampling and analysis program. Task 3 describes report preparation. The attached table presents a cost estimate for completing the following scope of work.

Task 1 - Preliminary Activities

HLA will attempt to locate aerial photographs of the site from the years 1930 to 1969, (during mine operation) and a recent aerial photograph of the site. Select photographs will be purchased to assess historic mine activities at the site and to prepare a base map for the sampling and analysis program to be performed under Task 2.

HLA will interview additional former mine employees to assist in interpreting the historic aerial photographs to select appropriate sampling and analysis locations. We will collect meteorological data from existing resources to assess wind speed and direction to be used during the risk assessment, as discussed in Task 3.

Once the historical aerial photographs and meteorological data are reviewed, HLA will develop a sampling and health and safety plan for the field investigation. This document will identify the specific activities to be performed during the field investigation, required equipment, sample collection and handling procedures, and specific health and safety issues for the personnel involved in the field investigation.

Task 2 - Field Investigation

The field investigation involves three primary activities: underground storage tank closure, radionuclide survey, and site mapping.

Underground Storage Tank Closure

ADEQ regulations require that before closure, the USTs need to be registered with the State. At that time, the closure process can proceed. In the field, HLA will assess the presence of a second UST by digging a shallow excavation in the suspected location. The USTs will be pumped dry of remaining fluid. The residual fluid will be placed in 55-gallon drums and stored onsite prior to recycling. Once the fluid has been removed from the UST and vapors are vented below explosive levels, the UST will be removed with a backhoe, visually inspected for leaks, and hauled offsite for disposal. The soil surrounding the UST will be visually monitored and analyzed in the field with a photoionization detector for the presence of petroleum hydrocarbon vapors. Soils with detected vapors will be excavated and stored onsite on plastic sheets for subsequent remediation and/or proper disposal. Soil samples will be collected at the base and sides of the excavations and analyzed to verify that petroleum hydrocarbon-affected soil has been excavated.

Radionuclide Survey

Previous site surveys have indicated that the radioactive waste material from the Orphan Mine is not confined to the present fenced area. The intent of the radionuclide survey is to assess the extent (i.e., area and depth) of radioactive mine waste at the Orphan Mine. The field survey will evaluate both the area at the canyon rim and the area surrounding the lower mine workings. Data obtained from the field survey will be used directly in the risk assessment process. The key components of the field survey include:

- general gamma radiation survey
- grid node gamma radiation survey
- grid node beta radiation survey
- subsurface beta and gamma radiation survey
- physical sample collection for laboratory analysis

General Gamma Radiation Survey: The land area surrounding the present fenced site at the canyon rim will be surveyed using a gamma scintillation meter. The purpose of this survey will be to assess the lateral extent of radiation above natural background and to assess the total area to be included in the next level measurements. Natural background conditions will be established with the gamma scintillation meter for locations within one kilometer of the site. Small flags, fluorescent tape, or wooden stakes will be used to mark this outer boundary.

Grid Node Gamma Radiation Survey: Once the total area with radiation levels above natural background has been identified, the entire area will be subdivided into square grids 10 meters on a side. Larger or smaller grids may be used depending on the size of the area and the results of the general survey.

A detailed gamma radiation survey will be made of the grided area using a gamma scintillation meter. The field personnel will take readings at the surface of the ground and at about 1-meter-high at each grid node location (i.e., at grid line intersections). The area within each grid square will be scanned by walking slowly over it and observing the uniformity of the readings and noting the location and magnitude of the highest readings. More detailed readings will be collected at the ground surface to define the areal extent of the highest readings.

Given the maximum public exposure of 0.002 rem/hr (2 mR/hr) identified in Section 3.3. areas that are identified in the gamma radiation survey that meet or exceed this value will be identified with a different color of flag, tape, or stake than was used to define the outer limits of the mine waste area. If the surface level readings are used to define the 2 mR/hr and higher areas, a conservative estimate of the area exceeding the hourly limit will be obtained. Total-body exposures that would be experienced by Park visitors and staff would be expected to be much lower than the readings at the ground surface.

Grid Node Beta Radiation Survey: Either concurrently or sequentially, the grid node survey will be repeated with a Geiger-Mueller (GM) counter. Two sets of readings will be collected, one with the GM meter cover open to measure total beta and gamma radiation, and one with the cover closed to measure gross gamma activity. Gross beta activity is determined by subtracting the gross gamma activity from the combined gross beta/gamma activity. As part of this exercise, gross gamma readings will be collected concurrently with the scintillation and GM meters to assess the level of agreement between the instruments.

Subsurface Radiation Measurements: Once the surface radiation survey data have been collected, the areas of highest surface radiation readings will be examined to assess locations for subsurface radiation measurements. Subsurface areas should be measured because areas with high radiation could result from the presence of subsurface material with high radiation. A few areas of low readings will also be examined because the potential exists for higher subsurface radiation readings in areas where low readings were encountered at the surface. The excavation equipment used to remove the USTs will be used to dig shallow trenches across a few of the identified areas. The trenches will likely begin and end in the areas of the low radiation readings and cut a cross section through the zone identified as having the highest surface readings. Because of the shallow depth underlying the bedrock, it is anticipated that the trenches will be no more than two feet deep and no wider than the width of a backhoe bucket. The excavated material and the lateral and vertical extent of the trench will be surveyed with the scintillation and GM meters to assess the vertical extent of the mine waste. The surface and subsurface data will be used to an estimate of the quantity of radioactive mine waste at the upper mine area.

Physical Sample Collection: Soil and rock samples will be collected from various surface and subsurface locations. Sample collection sites will include:

- outside the identified mine waste area
- inside the identified mine waste area
- areas with radiation readings above background but less than 2 mR/hr
- areas with radiation readings above 2 mR/hr
- areas inside the shallow trenches
- areas with the highest radiation readings

The collected samples will be submitted to a laboratory for gamma spectroscopy analysis. The primary purpose of the laboratory analyses will be to assess levels of uranium-238, thorium-230, and radium-226 in each sample. Other radionuclides may be identified using gamma spectroscopy methods if they are present in the samples at high enough levels.

Survey of Lower Mine Workings: Two members of the field team will hike down to the lower mine workings to perform a radiation survey of the area surrounding the "glory hole" and adit. If surface water is present in the lower mine area, a sample will be collected for uranium analysis. A less detailed survey than was performed at the upper mine area will be made at this location. It is intended the team members will complete the survey and make the round-trip hike in one day.

Site Mapping

Upon completing the investigative activities, the horizontal and vertical position of each marked location (flag, stake, excavation etc.) will be surveyed and tied into a site coordinate system by a registered land surveyor. These data and other site observations will be used to develop a detailed base map for the site. Field radiation survey results (beta and gamma) will be plotted on the base map for use in the risk assessment.

Task 3 - Project Report

A draft report will be prepared and submitted to the NPS for review. The report will include documentation of the collected data, conclusions, and recommendations for additional work if required. The report will be revised based on the NPS comments and submitted to the NPS as a final document.

TABLE D-1. SITE INVESTIGATION
DIRECT LABOR BUDGET ESTIMATE
ORPHAN MINE SITE INVESTIGATION
GRAND CANYON NATIONAL PARK

TASK	ASSOCIATE SCIENTIST	SENIOR SCIENTIST	PROJECT SCIENTIST	STAFF SCIENTIST	TECHNICAL EDITOR	WORD PROCESSOR	CLERICAL	GRAPHICS	TOTAL
Task 1 - Preliminary Activities									
Geologic summary	8					2			10
Review applicable state regulations	16		16			4			36
Aerial photo survey	16			16		4			36
Task 2 - Field Investigation									
Sampling and analysis plan	4		8	16	4	8			40
Health and safety plan	2		4	16	4	8			34
Underground storage tank closure	8	16		36					60
Radionuclide survey	48	48				8	4		108
Task 3 - Report	15	25	20	0	5	12	8	15	100
Total hours	117	89	48	84	13	46	12	15	424
Hourly rate ($)	95.50	63.66	58.13	49.14	35.99	40.13	35.99	35.99	
Subtotal cost ($)	11,174	5,666	2,790	4,128	468	1,846	432	540	27,043

Note: Eight field days with two people are scheduled for Task 2.

TABLE D-1. SITE INVESTIGATION (continued)
OTHER DIRECT BUDGET ESTIMATE
ORPHAN MINE SITE INVESTIGATION
GRAND CANYON NATIONAL PARK

Task 1 - Preliminary Activities	
Aerial Photo Survey	
8 Photographs @ $50	$400
Task 2 - Field Investigation	
Sampling and Analysis Plan	
Computer time 8 hours @ $25/hour	$200
Health and Safety Plan	
Computer time 8 hours @ $25/hour	$200
Underground Storage Tank Closure	
Laboratory fees 5 samples @ $100 each	$500
Equipment rental	$400
UST Excavation and disposal cost (assuming no over-excavation of affected soil)	$6,000
Radionuclide Survey	
Equipment rental (radiation meters) 7 days @ $90/day	$630
Personal protective equipment (coveralls, boots, TLDs, etc.)	$800
Air travel - 2 roundtrips @ $800	$1,600
Per diem/hotel 16 days @ $100	$1,600
Rental car 8 days @ $50/day	$400
Laboratory analyses 20 samples @ $100	$2,000
Surveyor (To be determined)	
Miscellaneous (estimate $500)	$500
Task 3 - Report	
Computer time 25 hours @ $25	$625
Reproduction	$200
Total cost	$16,055

TABLE D-2. RISK ASSESSMENT
DIRECT LABOR BUDGET ESTIMATE
ORPHAN MINE SITE INVESTIGATION
GRAND CANYON NATIONAL PARK

TASK	ASSOCIATE SCIENTIST	SENIOR SCIENTIST	PROJECT SCIENTIST	STAFF SCIENTIST	TECHNICAL EDITOR	WORD PROCESSOR	CLERICAL	GRAPHICS	TOTAL
Task 1 - Risk Assessment	75	40	150	50	16	28	8	18	100
Hourly rate ($)	95.50	63.66	58.13	49.14	35.99	40.13	35.99	35.99	
Subtotal cost ($)	7,163	2,546	8,720	2,457	576	1,124	288	648	23,522

OTHER DIRECT BUDGET ESTIMATE

Task 1 - Report	
Computer Time 56 hours @ $25/hr	1,400
TOTAL	$24,922

DISTRIBUTION

8 copies:

National Park Service
Denver Service Center
12795 West Alameda Parkway
P.O. Box 25287
Denver, Colorado 80225
Attention: Ms. Shelly Wells

QUALITY CONTROL REVIEWER

Robert A. Zimmer
Associate Environmental Scientist

Jere Johnson/R9/USEPA/US
02/23/2007 12:25 PM

To Philip Armstrong@EPA
cc
bcc
Subject Fw: Grand Canyon Briefing

Jere Johnson
Site Assessment Manager
EPA Region 9
415-972-3094
415-947-3520 (fax)
----- Forwarded by Jere Johnson/R9/USEPA/US on 02/23/2007 12:25 PM -----

Sara Segal/R9/USEPA/US
06/29/1999 11:24 AM

To Steve Dean/R9/USEPA/US@EPA, Jere Johnson/R9/USEPA/US@EPA
cc
Subject Grand Canyon Briefing

here's what the NPS sent me. fyi and any comments?

- brf_799.doc

Intermountain Denver Support Office - Office of Environmental Management
BRIEFING STATEMENT

February 23, 2007

Issue: Cleanup of the Orphan Mine at, Grand Canyon National Park

Background: The Orphan Mine Site, located 1.5 miles northwest of the South Rim Village , consists of a 3-acre upper mine area at the canyon rim and a lower mine area approximately 1000 feet in elevation below the rim. The site has been determined eligible for the National Register of Historic Places. The site is contaminated with radionuclides (including Uranium, Thorium and Radium isotopes) as well as heavy metals (including copper, arsenic and lead). Aloha particles have been found in the Horn Creek Spring in the lower canyon. The spring was historically used as a drinking water source by hikers. The contamination may effect visitors, residents, students, worker population and the flora and fauna in the area. The site is listed on the 1995 Federal Facilities Compliance Docket. It is not on the National Priorities List.

1906 to 1959 - Copper ore was mined
1951 to 1969 - Uranium ore was mined
1987 - The National Park Service (NPS) acquired full title to the property
1993 - NPS Western Region conducted a Preliminary Assessment and as required under the FFCA, a copy was sent to EPA-R9. Although the "score" was not high enough to include the site on the National Priorities List, it was recommended that the site be remediated. There were human health concerns raised due to the levels of radiation possibly present.
1996 - A human health Risk Assessment was performed to set cleanup goals for the site.
1997 - An Engineering Evaluation and / Cost Analysis (EE/CA)was begun in the fall.
1998 - A stake holders meeting with park representatives and regulatory authorities (EPA R9, AZ DEQ)was held in November. The EE/CA was put on hold, when it was realized further site characterization was needed. NPS asserted it authority as the lead on the clean-up. NPS and EPA will partner - EPA will provide technical advise for site.
- The park hydrologist noted that recent samples from Horn Creek spring showed alpha particles up to 90 pica curies.
1999 - With aid of EPA and the Navy, a 100% radiation survey in being performed on the site. This will aid in establishing background radiation levels and minimize soil removal.
- NPS is partnering with USGS is define the movement of radionuclides and heavy metals in the groundwater of the canyon. The goal of the study is to define whether the contamination in Horn Creek Spring is naturally occurring or caused by the mining. And to establish risk levels associated with the lower mine site.

General: Cleanup of the upper mine site will continue while the lower canyon water study and lower mine site investigation is in progress.

Public review: To meet CERCLA requirements, EE/CA's for both the upper and lower mine sites will be drafted and submitted for public review. The EE/CA will review the contamination issues at the sites and explain the development of remedial action alternatives. IMDE is the lead on the completion of the documents. Current timeframe for the public review of the upper mine site is Summer/Fall 2000. The lower mine site is dependent on the USGS study timeframe (as yet not established.)

106 status: Removal of the mining headframe and other structures on the mine site may be required for cleanup. Since the site may have historical significance the NPS is required to consult with the State and, if necessary, the Advisory Council on Historic Preservation. This process will begin once the 100% radiation survey is completed.

Potential Responsible Parties (PRP): A baseline PRP study has been completed. NPS is working toward cost recovery.

Tribal Interest: Local Tribes have be informed of the issues associated with the site. Grand Canyon staff have taken the lead in consolation and NPS will make all efforts necessary to assure Tribal concerns are addressed.

Contact at IMDE: Kris Provenzano, Office of Environmental Management, 303-969-2671

Contact at GRCA: John Beshears, Park Engineer, 520-638-7908.

303·415·9014 Sean Mulligan - NPS Counsel
shawn_mulligan@nps.gov

Orphan Mine 1·31·01 Michael Hingerty, Greg Boisseau, Sean Mulligan

Sean - Contacted NPS. Doing action memo for fence.
Need to address NEPA, Historic Act/Cultural concerns. Doing scope of work for EE/CA. RP may do EE/CA. Need confidentiality agreement.
104(e) ltr to 3 parties - Tucson (Veritoss Financial)
Cotter Corp
Other.

If rp doesn't do work, NPS will do & issue 107.
If rp does do work, do Admin Order on Consent, 104 agreement.
Needs DOJ concurrence.

Michael concerned about using 104 as basis for work agreements. We use 106, look at 104 as funding mechanism. Then 107 reimbursement.

1.17.01 Orphan Mine

PRP - Tucson (?) wants to know liability. Contractor out in Dec to determine thickness of stuff that needs to be removed. USPS contractor oversaw.

Went down to lower mine site (Glory Hole). Picking up lots of wtr from cliff.

Split samples w/ prp. RMC is Park Service contractor.

Mtg. w/ attnys next wk. Agenda item: coordination w/ EPA. Put together admin record, comm rels. plan. Finish EE/CA - PRP or USPS contractor. Park Service will oversee. Revising Harding Lawson EE/CA. Do hydro eval. of lower mine site. Need to cover Glory Hole or re-route wtr coming in. Steve wants to sample Glory Hole. 3 1/2 hr. Trip to Glory Hole.

Jay talking to Weston (START detachment), also looking to CH2M Hill, others pre-qualified.

Interested in getting START out to finish survey: Need to get cultural resource staff out too. Steve - Need to define bkgrd. Contractor for prp said all of Maricopa Pt. above Grd Canyon bkgrd. If prp contractor did depth, need START. Depends how reliable prp report is.

Shaft is venting radon! Next to elevator. Needs APS w/ charcoal filter. Reg. office experts could monitor. appliance

Worker safety issue. USPS has Health & Safety Plan.
Steve can help w/monitoring.

SETLOW.LOREN
11/23/98 09.03 AM

To. JOHNSON.JERE
cc. BALL.HAROLD, BANDROWSKI MIKE, DEAN STEVE, FEELEY.MICHAEL
Subject: Orphan Uranium Mine-Grand Canyon Responsiblities

** High Priority **

Jere,
In preparation for a conference call either today, November 23, or in the next week with the National Park Service(NPS) Regional Office in Denver, this e-mail constitutes my understanding of the current status of discussions and arrangements between the Office of Radiation and Indoor Air in Washington, Region 9 Superfund Division, the NPS Intermountain Region, and NPS Geologic Resources Division regarding the abandoned Orphan Uranium Mine, Grand Canyon National Park, Arizona This includes discussions held between you and I and Steve Dean over the last 3 weeks, the meetings I held with NPS personnel in Denver October 19 and 23, the meeting attended by yourself, Steve and I at the Grand Canyon November 4 and 5, a phone call I had with Kris Provenzano at the NPS on November 12, and a phone call I held subsequently with Steve last week:

We have agreed that you are to be the EPA project lead for this site.

All parties have also agreed that the NPS contractor prepared 1996 draft risk assessment and supporting radiological survey and sampling is inadequate, and that a resurvey of the site along with new hydrological geochemical/radionuclide studies is required. To that end, ORIA has committed its own operating funds and staff to take the lead in the resurvey, soil and core sampling, and hydrological studies of this radioactively contaminated site. As the ORIA funds involved are not Superfund derived, and are part of our national commitment to support EPA*s regional offices in identification, evaluation of, and cleanup of radiologically contaminated mining legacy wastes, there is no constraint on our working on Federal facilities. Recognizing Region 9's responsibility in reviewing and approving actions proposed or taken by the NPS at this site, we have agreed to work in cooperation with you and Steve, and other region 9 personnel (which we believe should also include Michael Bandrowski) in the selection of methodologies and sampling scheme for the site resurvey to ensure that they meet agency standards for quality assurance and quality control (including MARSSIM as necessary) for radiologically contaminated and for potential NPL sites.

All parties also agreed that there was a need to do a 100% radiation survey of the upper mine haul-out location on the South Rim along with further soil sampling and coring at that location, a walking radiation survey scan of the old mine haul road, additional survey of the lower mine workings, and ground water/spring water sampling of the lower workings and spring below the mine, plus appropriate radiochemistry and metals chemistry analyses of the samples taken.

To the extent possible, we will also work with you, Steve, and regional personnel in identifying appropriate contractors or Federal teams capable of doing this field and laboratory work (note that we do have our own contractors for this as well). Accounting for the funds spent will be done according to Superfund standards should PRP*s be determined to be accountable for government reimbursement.

We agreed at the meeting in Arizona that Steve Dean would speak to personnel of the Navy*s *Sports Detachment* regarding the possibility of their conducting the radiological survey. It is my understanding that they attempted to contact Kristine Provenzano on this matter to see if the NPS would fund them directly for this work. In turn, she told me that the NPS would prefer that all surveying and sampling on this project be overseen by a single entity, and preferably EPA. We agree, and since the Navy cannot conduct the laboratory sample analyses, geological coring or hydrological evaluation for this site, we recognize that the field and laboratory work may need to be conducted by more than one contractor or subcontractor. As the EPA ORIA funds we have available for this project will likely not cover its full cost, the NPS has proposed developing an interagency agreement with us to provide the appropriate monies to complete the project, and to memorialize the understandings of the project in that agreement (an existing interagency agreement dated June 1995 between EPA and the NPS for environmental management of non-coal mines and funds transfer could be used as the initial umbrella for this project.) I propose that the terms and content of any such supplemental interagency agreement be coordinated between ORIA, Region 9, and the NPS.

Steve Dean told me last week that he would find out if the Sports Detachment would be willing to work for ORIA on an interagency agreement to carry out the radiological surveying, and promised to forward to me materials on their capabilities.

Based on discussions at the meeting in Arizona, you agreed to provide to the NPS and us a decision on what form any subsequent reporting on the radiological contamination of the site should take (expanded site investigation, report of investigation).

In our conversation two weeks ago, Kris Provenzano agreed to send to me and Steve copies of site maps she had located on the upper mine workings and building locations, and maps of the haul road. She will also provide radiological data obtained from air sampling in the vicinity of the mine carried out in previous years. I agreed to provide Kris with a copy of the February 1998 joint ORIA/Superfund guidance for soil cleanup of radiologically contaminated soils and sites (already sent by fax).

Given weather conditions at the site, and the time necessary for completing necessary arrangements for interagency agreements and contractor support, any surveying of the site will need to take place in the Spring or Summer of 1999. Site approvals will be coordinated with the NPS for appropriate permissions and also to evaluate whether there will be any impact on the Peregrine Falcon nest on the cliff near the mine.

Discussions and decisions to be made on site remediation will be made by the NPS in coordination with you and Region 9 Superfund. However, as we have been involved in development and application of new technologies for site remediation of radiologically contaminated mine lands and waters, and will have played a role in evaluation of the site radiation problem, we would like to participate in these discussions as an advisor when the project has reached that stage.

For your information I am enclosing a letter which the Park Service sent to me in June regarding ORIA participation in evaluation of abandoned uranium and other NORM contaminated mines on Park Service land.

If there are many matters I have overlooked or you feel need to be included in this set of understandings, please let me know.
I look forward to continuing to work with you, Steve, and Region 9 personnel and management on this and other radiation contamination projects in the near future.

Regards,
Loren Setlow
NORM Team Leader, ORIA

- HIGGIN~1.WPD

SOME ACCOMPLISHMENTS INCLUDE

- EXECUTED OVER $60 MILLION
- TRAINED AND OUTPLACED OVER 500 PEOPLE
- SERVICED 82 DIFFERENT CUSTOMERS
- COMPLETED 218 ENVIRONMENTAL PROJECTS
- DEVELOPED STATE OF THE ART UXO & G-RAM SERVICES
- 135 AREAS SURVEYED AND UXO REMOVED
- PROVIDED THE CITY OF VALLEJO 202 BLDGS FOR OCCUPANCY
- 25 BUILDINGS CLOSED
- 2 HISTORICAL LBP ABATEMENTS
- 1 CHEMICAL PLATING SHOP DEMOLISHED
- 12 EBS's PREPARED
- 270,000 GALLONS OF OILY WATER PROCESSED
- 185,000 GALLONS OF WASTE OIL PROCESSED
- 2 BIO-REMEDIATION PROJECTS STARTED
- MANAGED CRADLE TO GRAVE 9,500 TONS OF HAZ WASTE
- 21 WASTE SITE REMOVAL ACTIONS COMPLETE
- PERFORMED BRAC LAYAWAY INSPECTONS ON 6,600 BUILDINGS
- REMED. 5 1/2 ACRES (DRMO) = 970,000 LBS OF SOIL & PAVEMENT
- ASBESTOS SURVEY AND REMEDIATED 225 BLDGS
- REMOVED 97 UST's AND 15,000 FT. OF ASSOCIATED PIPING
- 33 *ABOVE GROUND STORAGE TANKS CLEANED AND REMOVED*
- SURVEYED & REMEDIATED 40 HIGHLY CONTAMINATED PCB SITES

CONTACT:

SSPORTS Environmental Detachment
Business Office, Code 110
P.O. Box 2135
Vallejo, CA 94592-0135
Voice: (707) 562-3262
Fax: (707) 562-3266

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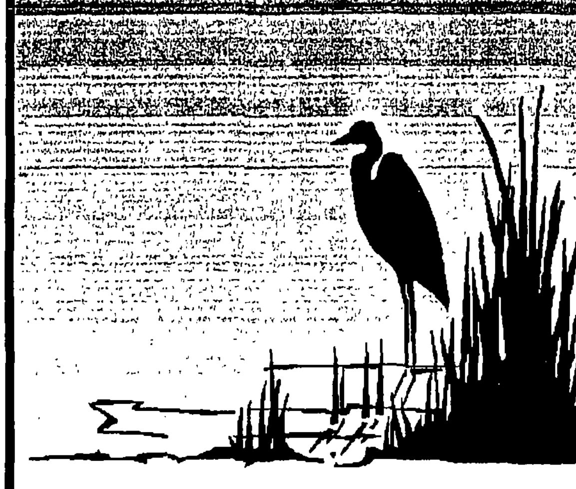
SSPORTS ENVIRONMENTAL DETACHMENT VALLEJO, CA.



PARTNERING

for everyone's benefit.

Remember! We don't inherit resources from our ancestors, we borrow them from our offspring.

SSPORTS ENVIRONMENTAL DETACHMENT VALLEJO

AS DIRECTED BY THE 1993 BASE REALIGNMENT AND CLOSURE COMMISSION (BRAC), MARE ISLAND NAVAL SHIPYARD CLOSED ON APRIL 1st, 1996 AND OUR DETACHMENT, ALREADY FULLY OPERATIONAL, OFFICIALLY COMMENCED WORK ON APRIL 2nd. SINCE OUR INCEPTION WE HAVE SUCCESSFULLY ACCOMPLISHED HUNDREDS OF ENVIRONMENTAL PROJECTS AT THE SHIPYARD AND SUCCESSFULLY EXPANDED OUR BASE OF OPERATIONS TO PROVIDE SERVICES TO 82 CUSTOMERS FROM 9 GOVERNMENT DEPARTMENTS IN 21 STATES. THE DETACHMENT HAS BEEN RECOGNIZED BY THE NAVAL SEA SYSTEMS COMMAND AS A "RESOUNDING SUCCESS" AND OUR ACCOMPLISHMENTS HAVE BEEN BOTH PUBLISHED AND APPLAUDED THROUGHOUT THE DEPARTMENT OF DEFENSE. WORKING CLOSELY WITH EPA OFFICIALS WE ARE CONSTANTLY STRIVING TO BRING OUR CUSTOMERS SAFER AND MORE COST EFFECTIVE WAYS TO PERFORM ENVIRONMENTAL WORK. OUR FINANCIAL STRUCTURE OF "FULL COST" RECOVERY IS ACHIEVED THROUGH AN EXTENSIVE SYSTEM OF CHECKS AND BALANCES AND WE TAKE PRIDE IN MAINTAING A SELF-SUSTAINING OPERATION WITH NO INCREASE IN PROJECT COSTS.

QUALITY PEOPLE AND QUALITY SERVICES MEANS QUALITY PRODUCTS FOR OUR CUSTOMERS. CALL US TODAY AND LET US HELP YOU WITH YOUR ENVIRONMENTAL PROJECT.

SOME CAPABILITIES INCLUDE

- ASBESTOS SURVEYS, ABATEMENT
- LEAD SURVEYS, ABATEMENT
- ENVIRONMENTAL BASELINE SURVEYS,
  - PARCEL SPECIFIC EBS
  - FOSL, FOST
- PCB SURVEYS
  CAD/CAM CAPABILITY
- INSTALLATION RESTORATION:
  - REMOVALS
  - FEASIBILITY STUDIES
  - GROUNDWATER MONITORING
- UNEXPLODED ORDNANCE (UXO)
  - SITE INVESTIGATIONS, SURVEYS
  - REMOVAL ACTION PLANS
- BRAC CLEANUP PLANS
- ECOLOGICAL RISK ASSESSMENTS
- EXCAVATION/SOIL SEPARATION
- GRADING AND PAVING
- FOUNDATION REMOVAL
- GEOGRAPHIC INFO SYS (GIS)
- SPCC PLANS
- CONTINGENCY/FACILITY RESPONSE PLANS
- UST REMOVALS
- ACCUMULATION AREA CLOSURES
- STORMWATER PPP
- OZONE DEPLETING SUBSTANCES SURVEYS
- RCRA FACILITY CLOSURES
- PART A & B PERMITS
- CATEGORICAL EXCLUSIONS
- RADIOLOGICAL CHARACTERIZATION
- STORM DRAIN CLEAN-OUT
- BUILDING DEMOLITION/MODIFICATION
- HEAVY EQUIPMENT OPERATION

SOME ADVANTAGES INCLUDE

- COST EFFECTIVE/CONVENIENT
- EDUCATED AND CAPABLE
- FIXED RATES
- NO PROFIT MARGINS
- LOW HOURLY RATE
- MATERIAL AT ACTUAL COST
- EXCELLENT COST & SCHEDULE RECORD
- EQUIPMENT INVENTORIES
- PARTNERSHIPS
- PRICE IS ACTUAL COST NO HIDDEN CHARGES
- IMPROVED RESPONSIVENESS
- DIRECT CUSTOMER/SUPPLIER RELATIONSHIP
- NON-PROPRIETARY DWGS
- INTERAGENCY AGREEMENTS, NO RFPs

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AGENDA

ORPHAN MINE, GRAND CANYON, ARIZONA

DATE November 4, 1998 (Possibly morning of November 5)
TIME 8 30AM - 5·00PM
LOCATION· TBD

GOAL To identify additional information and site work needed to prepare an Engineering Evaluation/Cost Analysis (EE/CA) for public review

"Begin at the beginning go on till you come to the end then stop "
- Alice's Adventures in Wonderland

TOPIC
TIME

(Estimates Only)

Introductions
8 30am

What's Been Done
9 00am
- History of mining and ownership
  - Discussion of Preliminary Assessment Work
- Discussion of Risk Assessment Work and Recommendations
  - Discussion of Data to be used for EE/CA (particularly the applicable or relevant and appropriate requirements, ARARS
- laws and regulations governing the site cleanup)

Concerns and Issues With Site and Proposed Remedial Actions 10 30am
  - Air Quality
  - Water Quality
  - Human Health
  - Threatened and Endangered Species
  - Historic (106)
  - Tribal Concerns

SITE VISIT
- After lunch, visit upper mine site area and try to view area of lower mine

Where We're Going
4 00pm
  - Funding
  - Finalize Project "Honey Do" list
- Schedule Next Meeting
  - Completion Timeline

PLEASE RECYCLE DATE \@ "MMMM d, yyyy" October 21, 1998

EMBED MS_ClipArt_Gallery

AGENDA
ORPHAN MINE, GRAND CANYON, ARIZONA

DATE: November 4, 1998 (Possibly morning of November 5)
TIME: 8:30AM - 5:00PM
LOCATION: Shrine of the Ages

GOAL: To identify additional information and site work needed to prepare an Engineering Evaluation/Cost Analysis (EE/CA) for public review.

"Begin at the beginning ... go on till you come to the end: then stop."
- Alice's Adventures in Wonderland

TOPIC	TIME (Estimates Only)
Introductions	8:30am
What's Been Done. - History of mining and ownership - Discussion of Preliminary Assessment Work - Discussion of Risk Assessment Work and Recommendations	9:00am
SITE VISIT (visit upper mine site area and try to view area of lower mine)	9:45am
What's Been Done (continued) - Discussion of Data to be used for EE/CA (particularly the applicable or relevant and appropriate requirements; ARARS - laws and regulations governing the site cleanup)	11:00am
Concerns and Issues With Site and Proposed Remedial Actions - Air Quality - Water Quality - Human Health - Threatened and Endangered Species - Historic (106) - Tribal Concerns - Geological and Radiological Needs	
Where We're Going - Funding - Finalize Project "Honey Do" list - Schedule Next Meeting - Completion Timeline	4:00pm

LUNCH - ONE HOUR SOMETIME AROUND NOON

11.4.98 Orphan Mine Mtg.

4 pot. ips. – Viability questionable.

☆ Get NPS example of 104(e) ltr to mines/milling facility

1 alpha in the creek below mine. 90 pci/L. Base is 12-24 pci/L.
Adjacent watersheds = 1 pci/L. MCL is 15.

NPS Concerns

Air Quality – State did 3-4 yrs air particulate data.
NPS will get data sets
Wtr. Quality

T & End. – Peregrine aerie. Nesting may cause delay to
work to do work w/out disturbing. Nest over cliff 8-1?
edge. Century milk vetch – Endangered plant at
Maricopa Point. Doubt grows near mill, but
botanist will do survey.

Headframe – NPS work w/ AZ Office of Historic Preservation.

Tribal Groups – 9 Havasupai, Hopi, Navajo, Zunis etc.
NPS has good working relationships.

Revegetation – Use Grand Canyon N. veg expertise

EPA Recs

Use Sea Van for roads? Haul road may be impassable
Use backpack, sprayers also.

☆ How do we structure this in the CERCLA process?

☆ How does waste and disposal fit into RCRA requirements

☆ Review proposal on water sampling by NPS.

☆ Talk to Regional Counsel about enforcement confidentiality

✓ NPS will send formal letter and request ARARS.
Luis will send copy of radia. site char. & site cleanup criteria. On EPA Home Page on radiation.
✓ NPS will collect vegetation samples and send to Steve for Reg 9 lab.

U:b?
703.335.3500

Steve Dean
11/02/98 09 20 AM

To: Jere Johnson/R9/USEPA/US@EPA
cc
Subject Orphan Mine

---------------------- Forwarded by Steve Dean/R9/USEPA/US on 11/02/98 09 23 AM ---------------------------

Richardv Graham
10/30/98 04·50 PM

To Steve Dean@EPA
cc
Subject *Orphan Mine*

Steve Its a long story but I have the time to write NPS-Geological Resources Division, HQ, is stationed here in Denver. Over 5 years ago I was working with their geologist/bat specialist/radiation staff member on mines in UT, NM, and elsewhere I provided him equipment for monitoring, review of his documents, and advised him on U toxicity/Rn inhalation, mining chemistry, etc Because of this relationship, we (R8) have been working with those guys on U mines, coal mine,
AML cleanup, etc

This April, I held a U mining Conference in Grand Junction, CO where Federal agencies (BLM, USGS, USFS, NPS, EPA,) and 4 state agencies came and talked about their problems I invited Loren, who sat and thought about how to get these troubled mines off the ground Bob Higgins, NPS Chief GRD, suggested EPA pay for cleanup of a "poster child" mine. EPA got publicity and NPS got the area cleaned Hence, our idea to get the Orphan cleaned up. Loren got the $ this year from Superfund for cleanup. In the meanwhile, no one here in Denver, either the NPS Regional Office or HQ knew that the Park had the RA done So, while two mine meetings were held here in Denver (one last week, the other this week) Loren and I met with Kris Provenzano, NPS Contaminants Specialist for the Intermountain Region She just got back to the continental US from Alaska, so didn't know of all these happenings

Yes, I saw the Risk Assessment, and agree that more characterization is needed I talked to Las Vegas about using their van and NAREL about sample support Because of Loren's HQ status, I believe we can get more characterization done without taking all of Loren's (HQ) NPS money but probably without cleaning the site up (I recommended to Kris that the NPS cleanup to background just "because" of its status and publicity Forget costs and risks!). Thats up to NPS to use their $ to finalize the cleanup

Now that we here in CO (NPS and EPA) know of the nature of the beast, the risk assessment, NPS/R9 involvement, etc I am sensitive to your concerns and needs So, don't be worried about my involvement I have enough to do here in R8 Because of our initial time investment and contacts with LV and NAREL, Loren was being nice about "looping me in". Be aware, there still are two other NPS concerns· 1) Load out station near rail spur has not been identified or sampled; 2) Blocking the path along the rim to the entrance of the "Glory Hole" down the rim. The Glory Hole is slumping into the canyon and is an extreme health and safety concern to the individual who gets the "bug" to hike all the way down there Easy solution is simply blocking the path down the rim

As far as your question about involvement, I am interested in the Sampling Plan, as I talked with our statistician about use of MARSSIM on the pile and want to learn more about nature and extent. But thats out of professional curosity I also believe that this site gives us (EPA) an opportunity to get the LV, NAREL, and HQ ORIA crowd their time in the sun, instead of our "superfund" guys (even though you and I are both supported by NPL funds). So, thats that!!

Give me a call Mon AM, if you want (303) 312-7080. Oh, last detail A woman for the NPS, is on detail to us (EPA HQ $) to develop AML NORM database. Diann Gese You'll meet her at the meeting next week

Regards,
richard

Orphan Mine 10.27.98 Alison 626 0400 x 1205

$22⁵ 267 total

Contam of concern radium & daughters. ↑ decay = ↑ risk.
Radium 1600 yr ½ life. Radium^{226} ← Uranium^{238}
Radium → radon gas → ↑ energy gamma emitters.
When stable becomes Pb.

Risk Assessment

Author doesn't understand reg. authority.
40 CFR 192 appropriate authority: Uranium Mill Tailings (UMTRCA) Radiation Control Act.

Extract Uranium^{235}, sp. out 238 and use as military applic. Very dense metal. U^{238} toxic to kidney. Drinking wtr std looks as heavy metal.
5 pCi/gm of Uranium is UMTRCA std.
(226 + 228)

Conference Call w/ Loren 10.28.98

Mtg in Reg 8 re: abandoned uranium mines 4 98
SF, OECA, Water, Radiation, Tribal etc.

NPS Geologic Resources interfaced w/ Loren. 1995 handheld survey by NPS found site was relatively "hot".

Loren has $125K. measurement effort so far incomplete. Use mobile lab out of Las Vegas. Soil analysis by Montgomery Lab. Chris has set aside $100K for prp search. Chris wants to have site cleaned up FY2000. Park has conflicts between historic preservation and tribal influences. Internal mtg 10-3.

Options

1. Clean up to UMTRCA std.
   Loren says is minimum - would like to cleanup to bkgd. We agree.
   For radium 226 & daughters.

We could offer to do modelling for site

Geologic and radiologic data needs should be added to agenda.
Move site visit up to after discussion of history.
MARSSIM manual? Designed for grid sampling, but some coverage can be better.
Leave message for Kris.
Loren has ICF Kaiser, SAIC, Trinity Engineering available to do sampling.
NAREL? Nat Air & Rad Environ Lab - Montgomery Ala.
Risk modelling Loren uses Rogers & Assoc, Cohn and Assoc. NAS just blessed Rogers rpt.
@ 125K sample collection and modelling.

FD. 10 = Jeff Woodley x 1487

Kris_Provenzano@nps.gov on 10/22/98 08:48:06 AM

To johnson jere
cc
Subject Orphan Mine Meetings

Had you name misspelled Hope this make it to you
Kris

______________________________ Forward Header ________________________________
Subject Orphan Mine Meetings
Author Kris Provenzano at NP-DENVER
Date 10/21/98 4:52 PM

Hello all -

Attached is a copy of the Agenda for the meetings at Grand Canyon
MEETING LOCATIONS ARE TO BE DETERMINED - JOHN BESHEARS WILL E:MAIL AS SOON AS ROOMS ARE SET

Jerry - Would you forward this message to the "radiation guy" in your office (I have the name down as Steve Dean - is that correct and is he still coming?) I was thinking that if we start getting into great depth on the Risk Assessment science, and we start loosing people, we may need to break on the subject and meet on Thurs or a later date to re-address. Your thoughts?

Travel Information
Fly to Las Vegas then directly to Grand Canyon (GRCA), or
Fly to Flagstaff and drive 1-1/2 hours to GRCA, or
Fly to Phoenix and drive 4 hours drive GRCA

You should be able to tell the guard your on official park service business I'll leave your names at the door if that is what is needed

Lodging
I have reserved rooms at the Albright training center in the park
The rooms are supposed to be quite nice - each has a kitchenette, but no phone in the room. (The park hotels usually do not have phones in the rooms either. Two rooms are reserved in Jerry's name for her and Steve or whomever; one room is reserved in Barney's name (rate $30/night) Call Anne Johnson at 520-638-7980 to confirm

Thank you in advance for your interest and participation in this project

Regards,
Kris (303-969-2671)

Wednesday Nov 4 (and Nov 5) Meeting Participant List

John Beshears, Park Lead, Engineer, GRCA
Carl Bowman, Air Quality, GRCA
Doug Brown, Compliance, GRCA
Kris Provenzano, DSO CERCLA contact, IMDE
R V Ward, Wildlife Biologist, GRCA
Jerry Johnson, EPA, Region 9
Steve Dean, EPA, Region 9
Barney Oldfield, Arizona DEQ
Shawn Mulligan, WASO-Hazmat, Solicitor

Tentative -
Supt or Assist. Supt. GRCA
Curt Edlund, Chief of Maintenance, GRCA
Diann Gese, WASO-GRD
Loren Setlo (EPA WASO)

- 11498adg doc

Orphan Mine Site (NPS)

Mike Shine

~~(970)~~ (303) 969-2877

re: Docket

States Planning &
Wastelan association

8th update
proposed for addition 11/10/93
as NPS - Grand Canyon
National Park

9th update
Name change proposed 4/1/95
to NPS - Orphan Mine

ltr. found / 3/2/94 req. change
from Interior

→ Mike will be back in
his office on 6/2

Records Center
matching m
CERCLIS listing
1/7/98

Grand Canyon News

-10, 1998 Number 44 ©Copyright 1998, *Williams-Grand Canyon News* Internet address — www.grandcanyontourguide.com

eek
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A scenic tour of the Canyon's west side

By Jeff Quinn
GCN editor

As fall colors begin to grace northern Arizona and the Grand Canyon area, West Rim Drive opens to automobile traffic and visitors are able to motor through the eight-mile stretch at their own leisure.

West Rim Drive makes its way westward from Grand Canyon Village just west of the Bright Angel Trailhead. It snakes past spectacular views of Grand Canyon Village below before reaching Maricopa Point.

Maricopa, Hopi, Mohave and Pima Points offer panoramic vistas of the Canyon. Sunlight, clouds and moisture perform magical feats of illusion and transformation on the Canyon below.

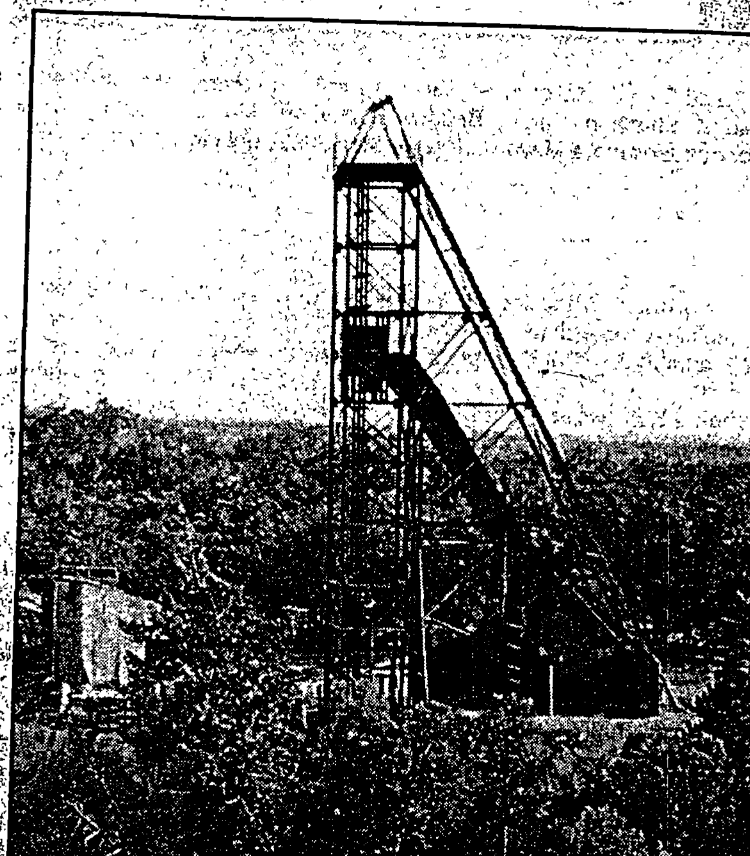
Powell Point and Memorial lets one admire the tenacity and conquest of the Powell explorations that took place in the 1800s.

Major John Wesley Powell and his party were very instrumental in the development of early maps and geological data relating to the Grand Canyon.

A plaque set on top of a stone framework honors Powell's party. Well, at least most of them. It fails to honor Bill Dunn along with Seneca and Oramel Howland, who left the main party at Separation Rapid and walked out onto the North Rim.

The trio was supposedly killed by Shivwits Paiute Indians, although there is no hard evidence

See West, Page 2B



Jeff Quinn/GCN

The headframe from the Orphan Mine towers above the west rim near the Powell Memorial.

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By Jeff Quin
GCN editor

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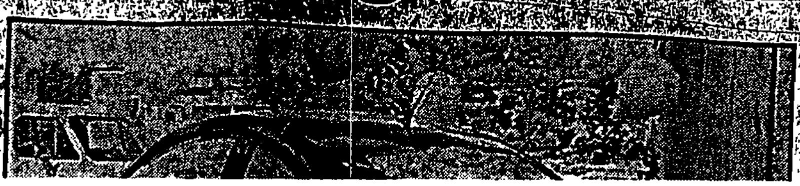


By Jeff Quinn
GCN editor

It would appear most of the Grand Canyon-Tusayan community was on hand Tuesday to celebrate

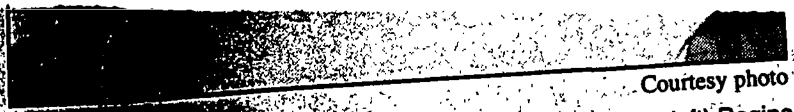
Charm" is a story about gypsies and the true meaning of Christmas.

The show will be held at the Grand Canyon Best Western Squire Inn in Tusayan.

The show will be followed by a buffet dinner, the ticket price of the show is yet to be announced.

Anyone interested in learning more about the GCBA or the Christmas show can call Sonja Rojas at 638-9788.

Look for a new segment in the *Grand Canyon News* entitled "Dancer of the Month" coming in November.



Courtesy photo

The Grand Canyon Ballet Academy — Ballet I performers,(from left) Regina [illegible], Shannon Harris, Brittany Buchanon, Monique Streit, Kailee Taylor [illegible] Alexandra Meyers. (Natalie Martinez is not pictured)

• West

From Page 1B

to support the argument.

While at the Powell Memorial, one has the opportunity to look out at the existing "headframe" of the Orphan Mine.

Originally claimed by Dan Hogan in 1893, the mine produced copper and silver.

Hogan accessed the minerals by traversing two different routes that led 1500 feet below the rim. The sheer wall was accessed by daring souls that utilized ropes, ladders and pegged holes in the rock to make their way down to the shafts below.

Although Hogan owned the claims for some 60 years, the lack of ore and the problem of bringing what was there to market kept his profits to a bare minimum.

As luck would have it, after Hogan sold the mine and its interests for $50,000, rich uranium and vanadium deposits were discovered in the very rocks Hogan had been kicking aside for years.

The mine produced millions of dollars worth of uranium.

In fact, the mine became America's richest source of uranium during the 1950s and 60s.

By 1969 most of the high grade ore was mined out and in 1988 the mine was closed down.

Hogan worked in the unventilated, radioactive mine shafts for years but remarkably lived to the ripe old age of 90.

Hermit's Rest lies at the west end of West Rim Drive. Named after Louis Boucher, the white-bearded, white-maned, hermit that built several camps and the Boucher Trail in the canyon.

Riding atop a white mule named Calamity Jane who was adorned with silver bells, Boucher prospected for minerals below the rim. He also worked for John Hance and Pete Berry as a guide and for Niles Cameron at Ralph Cameron's Indian Gardens.

Boucher apparently received the nickname "Hermit" for his solitary, bacheloric, aloof ways. However, the name is somewhat of a misnomer, as Boucher did indeed entertain friends at his camps and interact as a guide.

Today, visitors can browse in the gift shop or tackle the Hermit Trail, which connects hikers to Dripping Springs, the Tonto Trail, the Waldron Trail or the Colorado River via the Hermit or Boucher Trail.

Jeff Quinn/GCN

The entrance to Hermit's Rest is signified by this rock arch. The gift store is directly behind out of sight.

Jeff Quinn/GCN

The Powell Memorial sits prominently above the steps on Powell Point. Visitors can receive dazzling views of the Canyon from this vantage point.

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Delineation of non-point sources of uranium

James K. Fitzgerald, David K. Kreamer, Kevin H. Johannesson, and John R. Rihs

ABSTRACT

The Orphan Uranium Mine, located in the eastern Grand Canyon, is at the headwaters of Horn Creek drainage which presently discharges hostile effluent containing uranium above the US EPA maximum contaminant level for gross alpha (15 pCi/l). Byproducts of mine operations are a likley non-point source of uranium contamination. Geologic and water quality data suggest that water in Horn Creek is derived from two sources: 1) the South Rim Aquifer; and 2) water stored in Horn Creek basin. Base flow to Horn Creek is a product of spring discharge from Paleozoic carbonate rock (i.e., South Rim Aquifer). The latter water has a pH > 7, high buffering capacity, an average ^{238}U concentration of 24 ± 0.3 ppb, and is classified as a Ca-Mg SO_4^{2-} water. The discharge rate at high flow (winter to spring) is a factor of three greater than at low flow. Precipitation and storm-runoff captured in the basin are the likley sources of recharge. Consisting of debris deposited locally, a shallow unconfined aquifer holds water with significantly different chemistry: pH < 6, low buffering capacity, and a ^{238}U concentration of 92.7 ± 0.1 ppb. Recharge to the unconfined aquifer is not in equilibrium with the aquifer matrix and actively dissolves uranium from waste rock. As a result, effluent contains higher uranium concentration during the high flow regime. Data suggest that the non-point source of uranium is probably waste rock which has been inter-mixed within Horn Creek basin as a result of historic mining operation.

INTRODUCTION

Uranium mineralization is relatively common in the southwestern United States and, in particular, in the region surrounding the Grand Canyon in northern Arizona (Fig. 1) (Whenrich and Huntoon, 1989). These uranium deposits commonly occur as mineralized karst breccia pipes which have stoped upward since the Mississippian and Triassic (Whenrich, 1986). The Orphan Uranium Mine, located in the eastern portion of the Grand Canyon, below the South Rim, exploited one of these mineralized breccia pipes from 1951 to 1969 (Fig. 1).

Mineralized karst breccia pipes are typically located in the basal members of the Redwall Limestone up through the Kiabab Limestone. Inward collapse structures create breccia zones of high porosity in rock material which is in the latter stage of diagenesis. According to Wenrich (1986), low-temperature fluids mineralized these breccia pipes between 190 and 200 Ma.

Horn Creek basin is located directly below the mine and discharges waters containing uranium concentrations above the maximum contaminant level set forth by the United States Environmental Protection Agency (US EPA) (Fig. 2). Two possible non-point sources of uranium are present as a result of the mining operation: 1) waste rock washed into Horn Creek basin during the mining operation; and/or 2) secondary porosity created by mining within the Paleozoic strata.

A study addressing hostile effluent from Horn Creek was undertaken to distinguish the possible origin of contamination, and to interpret the geochemical evolution of uranium using uranium series disequilibrium. This study was designed to: 1) characterize the site at the Phase I level; 2) determine the origin of spring water at high and low flow regimes; and 3) distinguish the possible non-point source of uranium.

Several research groups have investigated and established baseline water chemistry for many of the Grand Canyon Springs. Foust and Hoppe (1985), for example, conducted a 10-year hydrogeochemical survey of both North and South Rim springs. Goings (1985), Zukosky (1995), and Fitzgerald (1996), from the University of Nevada, Las Vegas, have studied the geochemistry of Horn Creek water since 1984. In 1985, Energy Fuels Incorporated drafted an Environmental Impact Statement for the Canyon Uranium Mine located southwest of the Orphan Uranium Mine (EIS, 1985). The mine is required to monitor the gross-chemistry and radionuclide concentrations in South Rim groundwater. Monitoring stations include the Canyon Mine Well, Indian Garden (i.e., Two Trees Spring), Havasu, and Blue Springs (Fig. 2).

HYROLOGIC SETTING

Horn Creek basin has an average winter air temperature of 15 ^{0}C while during the summer, air temperatures exceed 25 ^{0}C. Snow and rain in the winter, are coupled by convection storms, common in the summer (Brown and Moran, 1979). Within the Colorado River gorge and on the South Rim, the average annual precipitation over the last eleven years was 40 cm/yr (NPS, 1996) (Fig. 3).

A tributary to the Colorado River, the Horn Creek stream valley is underlain by sedimentary rock deposited in the Cambrian and filled with Quaternary sediment eroded from steep canyon walls composed of Cambrian rock. Quaternary sediment is deposited in the stream valley by mass wasting and has been reworked by modern fluvial processes. The sediment is poorly sorted and consists of siliciclastic and carbonate rock fragments from Cambrian rock material. Quaternary strata ranges in thickness from 0 to 200 meters, and the basal members are well cemented by caliche, whereas the upper members tend to be unconsolidated.

The Orphan Uranium Mine breccia pipe has multiple collapse structures which juxtapose the surrounding horizontal and originally continuous Paleozoic strata (Gornitz and Kerr, 1970). Viable amounts of Cu, U, Pb, Zn, Ni, Co, Mo, and As were mined from the mineralized breccia pipe. Additionally, anomolously high levels of Hg, V, As, and Se are found in the pipes. The paragenetic sequence of breccia pipe mineralization is summarized into five steps by Wenrich (1985): 1) deposition of calcite, dolomite, barite, siderite, anhydrite, and kaolinite by a saline brine similar to Mississippi Valley Type (MVT) deposits; 2) deposition of siegenite, bravoite, pyrite, arsenopyrite, and marcasite rich in Ni, Co, and As; 3) deposition of Cu-Fe-Pb sulfides; 4) deposition of uraninite by low temperature groundwater onto coarsely crystalline calcite matrix, in vugs, and detritus quartz grains; and 5) deposition of CuS minerals including malachite, azurite, and covellite.

At the Orphan Uranium Mine, uraninite is located at the margins of the breccia pipe (Gornitz and Kerr, 1970). During operation, the mine produced 4.6 million pounds of U_3O_8 which ranges in grade from 0.3 to 55% in hand sample (Gornitz and Kerr, 1970), 6.68 million pounds of Cu, 107,000 ounces of Ag, and 3,400 pounds of V_2O_5 (Wenrich and Huntoon, 1989). As noted, large volumes of ore and waste rock were removed from the mine. Mining activity has anthropogenically weathered the breccia pipe, providing an effective source of highly reactive minerals which readily react with oxygenated water (i.e., sulfides and oxides). Waste rock, produced during the mining operation, is known to be detrimental to water quality (Earman, 1996).

For the purpose of this investigation, the surface and groundwater drainage area within Horn Creek basin and below the South Rim, is classified as the inner-basin. It necessarily follows that the volume of debris present in the inner-basin is a function of the surface-water drainage area below the rim. Horn Creek inner-basin has an area of 0.6 km^2 and is bound by 800 meter high vertical canyon walls composed of Paleozoic sedimentary rock (Fig. 4).

Horn Creek is classified as a third-order stream channel and subdivided into three reaches: 1) the upper-most reach has a near vertical channel gradient and consists of multiple low-order drainages which drain the Orphan Uranium Mine orifice; 2) the middle reach has a gradient of 54% which converges with the lower-most reach; and 3) the lower channel has a hydraulic gradient of 10% and perennial discharge (Fig. 2 and 4).

As this investigation will show, the Horn Creek inner-basin appears to have developed a inner-basin unconfined aquifer which strongly influences the annual discharge and water chemistry of spring water. As noted, Quaternary strata is cemented by layers of caliche which, in turn, form impermeable layers. From the rock type, average discharge rate, and the hydraulic gradient in the aquifer, the hydraulic conductivity was calculated to be $K = 4.3 \times 10^{-4}$ m/s by this investigation.

Spring flow into Horn Creek basin occurs on a perennial basis from the South Rim Aquifer. Owing to lithification, the Paleozoic sedimentary rocks, which contain the South Rim Aquifer, have low primary porosity (Huntoon, 1982). Currently, no quantitative estimates of hydraulic conductivity are published in the literature. Faults, joints, folds, karst features, and breccia pipes form a network of secondary porosity that concentrates zones of high hydraulic conductivity (Metzger, 1961; Huntoon, 1982). Horizontal groundwater flow through the South Rim Aquifer tends to be concentrated along the aquitard (i.e., Bright Angel Shale) (Fig. 4) which delivers water to Horn Creek basin (Huntoon, 1982).

In order to calculate an annual water budget, the annual average precipitation is taken to be 25 cm/yr; though there are no precipitation gages at the site (Fig. 3). Since Horn Creek basin is 2 to 3 thousand feet below the precipitation gage a conservative estimate of annual precipiation was made. In addition to rain and snow, other inputs to the basin include, spring discharge from the South Rim Aquifer and storm runoff from the canyon walls. Based on the Horn Creek watershed area (0.6 km^2) (Fig. 2), and the average stream discharge (i.e., about 30 m^3/day), the total outflow is ~ 9000 m^3/yr, which is 3% of the total input (i.e., annual average precipitation). Due to the arid climate in Horn Creek, evapotranspiration probably accounts for the majority of the output.

Springs that discharge from the South Rim Aquifer are known to discharge at a semi-constant rate (Metzger, 1961; Huntoon, 1982; USGS, 1996; Fitzgerald, 1996). Based on seasonal discharge measurements, the majority of recharge to the Horn Creek aquifer occurs during the winter (Fig. 5). Moreover, due to winter precipitation and runoff captured in Horn Creek basin, there is significant seasonal fluctuation in stream discharge (Fig. 5).

MATERIALS AND METHODS

Springs were sampled for major ions in July 1995 during low flow. In addition, Horn Creek three times between 1994 and 1996. Field physiochemical measurements were made (i.e., temperature, pH, alkalinity, TDS, and EC) in conjunction with environmental isotope sample collection (i.e., tritium and uranium).

The four major cations (i.e., sodium, magnesium, calcium, and potassium) were measured by atomic adsorption spectroscopy (AA). The detection limit of the AA method is approximately 0.01 ± 0.05 mg/l. Anion samples were analyzed using a Dionex ion chromatography (IC) system. Similar to the cation accuracy, the detection limit of IC is 0.01 ± 0.05 mg/l.

Uranium samples were collected in one liter polyethylene bottles. One liter grab samples were collected for analysis and were filtered through a 0.45 μm filter and acidified in the field to pH < 2 with ultra-pure 16 N concentrated nitric-acid. Uranium samples were analyzed at the Trace Metals Lab, University of Nevada Las Vegas (UNLV) using methods described by the EPA (US EPA, 1979). A high-resolution solid-state alpha particle spectrometer was used to count the alpha emissions produced by the uranium isotopes ^{238}U, ^{235}U, and ^{234}U. The minimum detection limit for uranium isotopes is less than 0.01 μg/l, with a 1-sigma error ± 5% for uranium concentration and ± 3% for the $^{234}U/^{238}U$ activity ratio (Ivanovich and Harmon, 1980).

RESULTS

Horn Creek spring was visited and sampled three times during the investigation. Spring flow occurred at two locations which appeared to depend on the flow regime. At low flow, for example, the spring orifice was located 100 meters above the Tonto Trail (Fig. 2). On the other hand, during the high flow regime (i.e., March 1993), the spring orifice was located 2000 meters above the trial (Fig. 2 and 4). Discharge, at low flow, issued from unconsolidated sediment along the west side of the stream bank, and was estimated to be 0.5 liters per minute (l/m). At high flow, the spring orifice was located in a debris slide cemented with caliche, and had a discharge rate of 1.5 l/m.

Table 1 summarizes the field physiochemistry measurement results from previous investigations and this study. Data collected during this study is consistent with previous investigations of Horn Creek water chemistry (Table 1). Differences in temperature and pH were noted during the high and low flow regime, where at high flow the water was cooler and had a lower pH. Additionally, the alkalinity was lower at high flow. Worth noting, the total dissolved solids (TDS) was similar during high and low flow and has decreased since 1979 (Table 1). Based on seasonal discharge rates and the average TDS, the mass loading from Horn Creek on an annual basis is approximately 200 kg/yr.

Major ion samples, collected during this study at low flow, had concentrations similar to those measured by previous investigations (Table 2). The charge balance for major ions in solution had less than 10% difference. Discharge from Horn Creek is classified as a calcium-magnesium sulfate water. Since 1979, there is a notable decrease in sulfate concentration. Additionally, chloride follows a similar pattern, but it is less abundant than sulfate (Table 2).

Water discharging at base flow had and an average ^{238}U concentration of 25 parts per billion (ppb), whereas water discharging during high flow had a ^{238}U concentration of 92.7 ± 0.1 ppb (Table 3). The $^{234}U/^{238}U$ activity ratio (AR) was at unity during low flow and below one at high flow. The uranium loading from Horn Creek on an annual average basis is 0.023 kg/yr. Tritium samples were collected coeval with uranium samples and contained background levels of tritium (i.e., < 10 TR) (Table 3) (Fitzgerald, 1996).

DISCUSSION

Seasonal water chemistry in Horn Spring (Table 1, 2, and 3) suggest that at high flow Horn Spring waters are derived from a short lived groundwater system (i.e., short residence time), whereas water at low flow is likely a product of spring flow from the South Rim Aquifer. This conclusion is based on four lines of evidence: 1) inner-basin geology and hydrology; 2) water quality; 3) major ion chemistry; and 4) environmental isotope chemistry.

As noted, Horn Creek is thought to be fed by spring flow from the South Rim Aquifer and the inner-basin unconfined aquifer. During high flow, the spring orifice is 2000 meters higher in the stream valley; this indicates that the water-table has raised and, as a result, Horn Creek becomes a gaining stream (Fig. 4). Dry periods (i.e., summer months), cause a decrease in the water-table elevation, and Horn Creek becomes a losing stream, fed by seeps from the South Rim Aquifer (Fig. 4).

There are distinct differences in basic water chemistry during high and low flow regimes. First, at high flow the temperature is cooler and the pH is lower (Table 1). Cooler waters at high flow indicate a shallow groundwater system that is uneffected by the local geothermal gradient; unlike warmer water temperature at low flow. Since the pH is slightly acidic at high flow, groundwater is probably not in equilibrium with the aquifer matrix, whereas the pH is slightly basic at low flow, suggesting some sort of quasi-equilibrium has been reached (Table 1). Moreover, Horn Creek at high flow has lower alkalinity which further indicates that waters have not equilibrated with the aquifer matrix. Since the TDS values are similar at high and low flow, there is no dilution of dissolved solids when the flow volume increases. The latter observation suggests that high and low regimes result from different groundwater bodies (Foust and Hoppe, 1985).

The basic and major ion chemistry (Table 1 and 2) at low flow was modeled using the ion-pairing reaction model PHREEQE, in order to simulate the geochemical evolution of waters. Based on output from the model, it appears that the water sampled at low flow is from the South Rim Aquifer. A two step simulation was conducted to depict and predict the geochemical evolution of Horn Creek's water. A target solution, which consists of the measured basic chemistry and major ion concentrations, was equilibrated with calcite, dolomite, and gypsum, in order to calculate the respective mineral saturation indices. The second step attempted to predict the average major ion concentration in groundwater using the average annual pH and dissolved constituents in South Rim precipitation (NPS, 1996).

For Horn Creek waters, PHREEQE predicted measured pH values and major ion concentrations with errors of 0 to 20 % of modeled values (Table 4). Since the low flow sample may have mixed with inner-basin water, the percent difference between model output and measured data is probably not statistically significant. PHREEQE calculated negative Δ phase values for the mineral calcite; therefore the model predicts the precipitation of calcite.

Counterintuitive, the total dissolved ^{238}U was present in greater abundance in Horn Creek waters during high flow regimes than during low flow periods (Table 3). As noted, the Horn Creek inner basin aquifer is unconfined and open to the atmosphere, so that at high flow regimes, theoretically, there is an infinite reservoir of CO_2 gas available. As a result, the effluent pH is slightly acidic (pH < 6) which spontaneously leaches uranium from the mineral phase, resulting in high total ^{238}U concentration and $^{234}U/^{238}U$ activity ratio < 1 AR.

The effective non-point source of uranium is probably waste rock which has inter-mixed with stream alluvium, rather than fluid migrating through the mine. This conclusion is supported by the following: 1) the physiographic location of the Orphan Uranium Mine; 2) sources of water at high and low flow; and 3) comparison of effluent chemistry at low flow to Salt Spring water which has not been affected by the Orphan Uranium Mine.

Figure 2 illustrates the location of the Orphan Uranium Mine adit relative to Horn Creek. The first-reach, classified in this study, drains the area directly below the mine orifice (Fig. 2). Waste rock, washed downgradient during storm events, has a direct path into Horn Creek's active stream channel (i.e., third-reach). During and post mine operation large volumes of waste rock could have been eroded, transported and subsequently deposited in Horn Creek basin. As noted, data suggest flow in Horn Creek has two sources: 1) the South Rim Aquifer; and 2) inner-basin aquifer. Similar to basic effluent chemistry, the uranium concentrations at high and low flow are significantly different (Table 3). Comparison to an undisturbed system further supports the inference that the non-point source of uranium is waste rock which has inter-mixed with Quaternary alluvium. Figure 6 is a scatter-plot of the total uranium concentration as a function of the $^{234}U/^{238}U$ activity ratio. The graph illustrates chemical similarities between Horn and Salt Springs at low flow. Conversely, the uranium concentration at high flow is greater by a factor of six (Fig. 6).

Summary

This investigation has shown that discharge from Horn Creek may be a product of two different groundwater bodies, and the likely non-point source of uranium is waste rock which has inter-mixed with alluvium within the inner-basin. Hydrogeologic evidence coincides with spring water geochemistry, in that, the spring orifice is at different locations at high and low flow, and spring waters have statistically significant differences. The latter conclusion is further supported when Horn Creek is compared to an undisturbed system with similar spring geology (i.e., Salt Spring).

Further research, addressing Horn Creek and contaminated water, should include soil and water sampling for gross chemistry, trace-metals, and radionuclides. A seasonal monitoring program should be established to further characterize water chemistry and interpret the long-term effects of the Orphan Uranium Mine waste. Before any steps are taken to correct the problem, the non-point source should be studied further. Especially since the type of clean-up method employed at the site is strongly dependent on the source of uranium.

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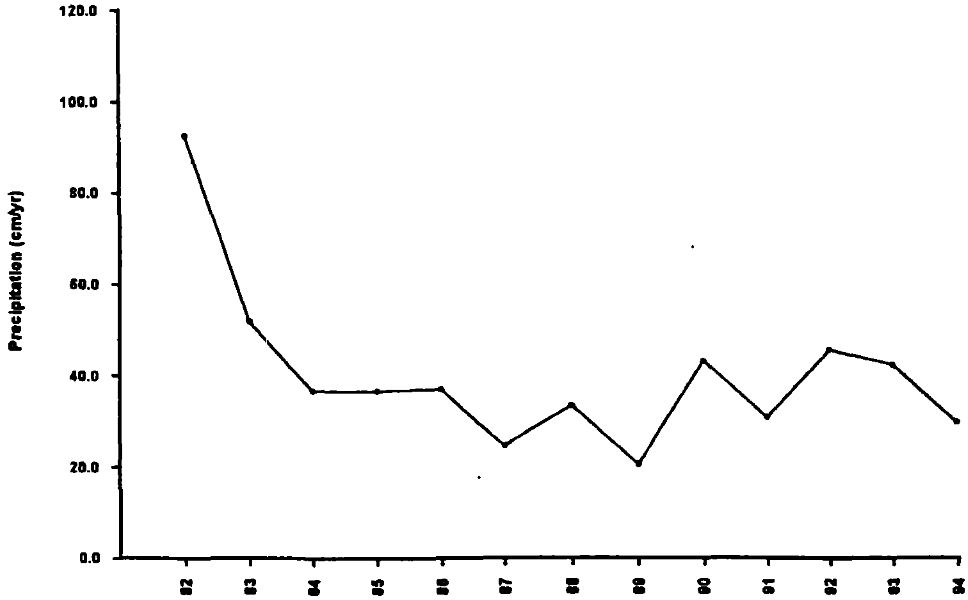

Figure 3. Annual average precipitation over the South Rim (centimeters per year) (NPS, 1996).

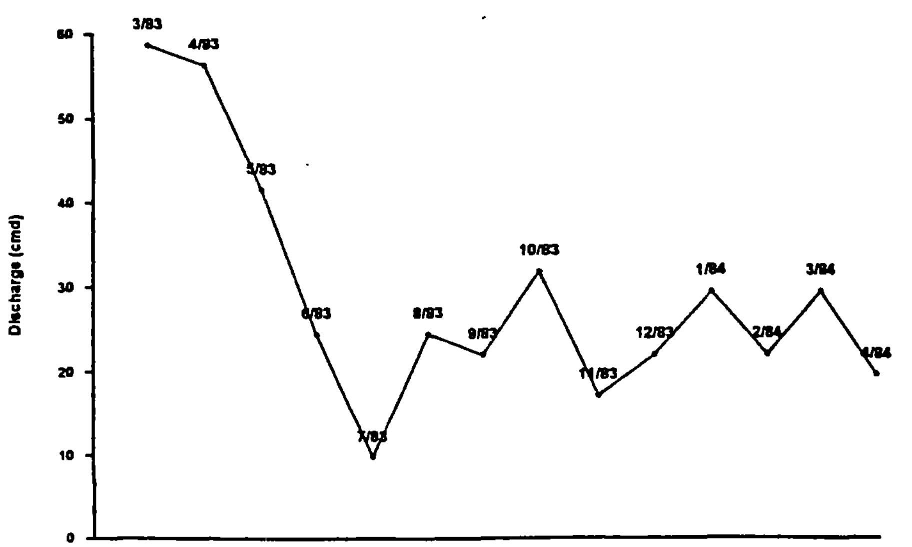

Figure 5. Discharge measurements at Horn Creek during 1983 and 1984 (cubic meters per day) (after Goings, 1985).

Table 1. Physiochemical measurements

Date	T*	pH	TDS**	EC^	Alk**
6/79	22.4	7.9	637	1.03	252
5/83	18	8.2	819	1.18	339
6/83	18	8	778	1.15	329
4/93	16.5	6	528	1.04	
6/93	24.1	7	502	1.01	
10/93	24	7	568	1.13	
3/95	13.5	6	527	1.05	198
6/95	17.2	7.1	522	1.03	235
7/95	21.5	7.5	503	1.01	280

* Water temperature in degrees Celsius
**concentrations in mg/l
^ units mS/cm

Table 2. Major ion concentration (mg/l)

Date	Ca	Mg	Na	K	F	Cl	Br	NO3	NO4	SO4
6/79	88.3	101	39.3	17	0.5	58.2				361
5/83	81.1	93	38.5	15		43.1				366
6/83	77.7	96	40.8	16		48.2				318
4/93					0.3	36.5	0.24	5.4		286
6/93										
10/93										
3/95										
6/95										
7/95	87.8	82	32.5	14	0	39.3	0.21	0.55	0.124	239

Table 3. Environmental Isotope Concentrations

Date	TR*	2-σ	UT**	1-σ	AR^	1-σ
4/93						
6/93						
10/93						
5/94	2.3	2.2	24.7	0	0.9	0.03
3/95			92.7	0.2	0.8	0.01
6/95	4.4	1.9	27.6	0.1	1	0.02

* Tritium ratio = 3.19 pCi/l
**Total uranium (ppb)
^uranium-234/uranium-238 activity ratio

Table 4 Results from chemical modeling (PHREEQE)

Parameter	Measured Molality	Modeled Molality	% Error	Δ Phase**
pH	7.0	7.0	0	
Calcium	0.0022	0.0019	14	-0.0035
Magnesium	0.0034	0.0027	21	0.0027

Bicarbonate	0.0046	0.0044	4	0.0027
Sulfate	0.0025	0.0027	7	0.0025

** negative Δ phase values indicate precipitation of mineral.

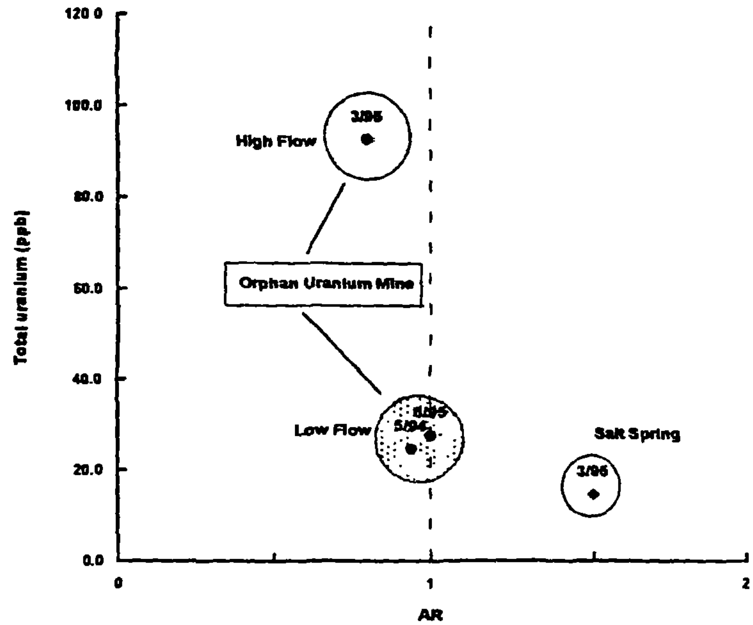

Figure 6. Scatter-plot of total uranium concentration (parts per billion) as a function of $^{234}U/^{238}U$ activity ratio.

Project Statement GRCA-N -33 .4 2

Last Update: 3/27/97 Priority: 5

Initial Proposal: 1996

Title : DELINEATE & EVALUATE NON-POINT SOURCES OF URANIUM

Sub-title: HORN CREEK ASSESSMENT

Funding Status: Funded: 1 .98 Unfunded: 7.21

Servicewide Issues : N2 (BASELINE DATA
N12 (WATER FLOW

Cultural Resource Type:
N
-RMAP Program codes : 1 (Water Resources Management

1 -238 Package Number :

Problem Statement

Horn Creek is located along the South Rim of Grand Canyon and is accessible to visitors via the Tonto Trail. This spring is an important drinking water source for backcountry visitors, especially in the summer months when daytime temperatures typically e ceed 1 degrees F. In 1992, the number of user nights reported for Horn Creek was 774. Since 1992 the amount of use has greatly increased.

The purpose of the study put forth in this proposal is fourfold: 1 Provide additional data on streamflow for an ongoing study (i.e., park funded on impacts to spring flow from groundwater withdrawals. 2 Delineation of non-point sources of uranium in Horn Creek. 3 Evaluate the e tent and character of contamination to better inform and protect the public. 4 Collect baseline water quality data for a variety of water resource issues, including; a contributing to our understanding of groundwater flow pathways, b identify other contaminants presence or absence, c evaluate the potential for effects of sewage effluent and landfill leakage on Horn Creek.

The Orphan Uranium Mine, located in the South Rim of eastern Grand Canyon, is at the headwaters of Horn Creek drainage which currently discharges hostile effluent containing uranium above the United States Environmental Protection Agency's (EPA ma imum contaminant level for gross alpha (15 pCi/L . Byproducts within the watershed and/or secondary porosity created by past mining activity are likely non-point source's of uranium contamination. Geologic and water quality data suggest that water in Horn Creek is derived from two sources: 1 the South Rim Aquifer; and 2 water stored in Horn Creek basin.

Base flow to Horn Creek during the summer months is a product of spring discharge from Paleozoic carbonate rock (i.e., South Rim Aquifer . The latter water has a pH>7, high buffering capacity, an average uranium 238 concentration of 24 +/- .3 ppb, and is classified as calcium-magnesium sulfate water. The discharge rate at high flow (winter to spring is a factor of three greater than at low flow. Precipitation and storm-runoff captured in the basin are likely sources of recharge. Consisting of debris deposited locally, a shallow unconfined aquifer holds water with significantly different chemistry: pH<6, low buffering capacity, and a uranium 238 concentration of 92.7 +/- .1 ppb. Recharge to the unconfined aquifer is not in equilibrium with the aquifer matri and actively dissolves uranium from waste rock. As a result, effluent contains higher uranium concentration during the phigh flow regime (Fitzgerald, Kreamer, ohannesson and Rihs, 1997 .

At present, warnings have been posted that water from Horn Creek is unfit for consumption. However, it is not desirable to allow the public to not consume this water if it can prevent serious illness or death. Long term monitoring of discharge and radionuclide concentrations may yield data that would permit lifting this drinking water advisory during base flow (summer conditions. This data may also contribute greatly to a risk assessment produced at some future date so as to better inform the public as to the hazards of consumption.

Data obtained from frequent and seasonal sampling will be used to determine if the source of contamination is from mine tailings in the watershed, and/or from runoff into the glory hole itself (secondary porosity . A study by Fitzgerald, Kreamer, ohannesson and Rihs (1997 shows that contamination is not dominated by natural groundwater conditions found in the South Rim Aquifer in that uranium levels greatly increase during high flow periods. Discharge data from Horn Creek will contribute greatly to a currently funded project monitoring South Rim springs for impacts from groundwater pumping just outside the park. Baseline water quality data will contribute to understanding groundwater flow pathways as well as identifying the effects, if any, of management actions that impact water quality and quantity.

Description of Recommended Project or Activity

The first step in implementing this study will include installing a stilling well (float/potentiometer , a V-notch weir as a control, and a datalogger at an appropriate, unobtrusive location on Horn Creek. Helicopter support will be needed to transport this heavy equipment. Once installed the site will be surveyed to establish site control (survey will be repeated once a year to assure quality data .

Baseline data collection will be conducted by sampling annually for the eight priority pollutant metals. Discharge will be measured periodically with a flume to develop a discharge rating curve. In addition, other physical parameters will be monitored, such as temperature, specific conductance, alkalinity, pH, dissolved o ygen, total dissolved solids, turbidity, phosphate, sulfate and nitrates. Samples will be taken (ten times a year for total uranium, uranium isotopes, gross alpha, and gross beta levels. The sampling frequency of 1 a year will be minimum to assure statistical validity regarding the critical focus of the project. For economy purposes sampling of metals, radon and radium will only be sampled annually. It is assumed that annual sampling of these will be of sufficient frequency to provide insight on how they relate to discharge and other parameters.

Soil samples will be collected once at three locations: one upstream and one downstream in Horn Creek and one from a similar site in an adjoining watershed as a control. Soils will be sampled for total uranium. A sample will be taken from one of the seeps emerging from the Coconino Sandstone above the Orphan mine glory hole, and if possible, one sample will be taken from standing water at bottom of glory hole.

Evaluate water quality and discharge data on a yearly basis. The final phase will incorporate findings into; 1 a final report presenting the data with an evaluation on the nature of the contamination, 2 an evaluation on the usefulness of the site for monitoring sewage effluent and landfill leachate and, 3 a risk assessment study to better inform and protect the public and, 4 groundwater flow pathway studies. In addition, recommendations on remedeation may be made.

Phase I -- Years 1 & 2

1 Collect soil and water quality data on Horn Creek.
2 Maintain stream gage and perform discharge measurements.
3 Produce, with annual update's, a discharge rating curve.
4 Update and maintain the parks' water resource database, including EPA's STORET database to optimize the usefulness of the data.

Phase II -- Year 2

1 Perform data analysis and produce final report.
2 If applicable, produce a risk assessment report.
3 Work cooperatively with the Geologic Resources Division and/or the Water Resources Division e ploring possible remediation strategies for the Horn Creek watershed.
4 Implement new drinking water restrictions through a variety of means, including interpretive signs.
5 Continue to operate stream gage for a statistically significant period of time.
6 Evaluate the need for the park to fund continued water quality monitoring and if so, at what sampling frequency.

Primary Costs:

Helicopter support ----------------------------- $8 .
lab analysis costs:
The Eight Priority Metals* - $2 . 8 =$1,6 .
Total Uranium -------------- $ 5 . 2 =$1, .
Total U. From Waters In and Above Mine ** = $1 .
Uranium Isotopes ----------- $2 . 2 =$4, .
Radium* -------------------- $ 8 . 8 = $64 .
Radon* --------------------- $ 8 . 8 = $64 .
Gross Alpha & Beta --------- $ 6 . 2 =$1,2 .
Gross A & B From Waters In and Above Mine**= $12 .
Soil Samples** ------------- $21 . 3 = $63 .
Total Lab Cost --------------------------- $9,81 .
Travel To and From Lab ---------------------- $1, .

* - annual samples (4 times a year
** - one time only samples

YTotal co t for 2 year lan = $11,730

BUDGET AND FTEs:

FUNDED

	Source	Activity	Fund Type	Budget ($1 s	FTEs
1996:	PKBASE-CR	RES	Recurring	3.66	.1
1997:	PKBASE-CR	RES	Recurring	3.66	.1
1998:	PKBASE-CR	RES	Recurring	3.66	.1
			Total:	1 .98	.3

UNFUNDED

	Activity	Fund Type	Budget ($1 s	FTEs
Year 1:	MON	Recurring	6.69	.
Year 2:	MON	Recurring	5. 4	.
		Total:	11.73	.

(Optional Alternative Actions/Solutions and Impacts

No action- This would increase visitor risk by preventing any consumptive use of Horn Creek. Valuable information on groundwater flow pathways will not be obtained. In addition, any chance of watershed restoration that would be linked to the Orphan Mine reclamation activities may be lost.

Reduce sampling frequency- Limiting sampling of all water quality parameters to annual sampling will eliminate any meaningful statistical analysis of the data, but will cut costs roughly in half. In addition, such a reduction may reduce the number of site visits to four a year.
Primary Costs for alternative sampling:

```
    Helicopter support ---------------------------- $8   .
    lab analysis costs @ 4 times a year for 2 years:
        The Eight Priority Metals -- $2  .    1 =  $2   .
        Total Uranium -------------- $ 5 .    8 =  $4   .
        Total U. From Waters In and Above Mine - =  $1   .
        Uranium Isotopes ----------- $2  .    8 = $16   .
        Radium --------------------- $ 8 .    8 =  $64  .
        Radon ---------------------- $ 8 .    8 =  $64  .
        Gross Alpha & Beta --------- $ 6 .    8 =  $48  .
        Gross A & B From Waters In and Above Mine = $12  .
        Soil Samples --------------- $21 .    3 =  $63  .
        Total Lab Cost ------------------------- $4,81  .
    Travel To and From Lab ------------------------ $4   .
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Total co t for 2 year lan = $6,010

Compliance codes : EXCL (CATEGORICAL EXCLUSION)

Explanation: 516 DM2 APP. 2, 1.6

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Meeting Notes
Orphan Mine, Grand Canyon, Arizona

DATE	November 4, 1998
TIME	8 30AM - 3 30 PM
LOCATION	Shrine of the Ages

BACKGROUND The Orphan Mine Site, located 1 5 miles northwest of the South Rim Village, consists of a 3-acre upper mine area at the canyon rim and a lower mine area approximately 1000 feet in elevation below the rim The site has been determined eligible for the National Register of Historic Places Contaminates of concern include radionuclides (including Uranium, Thorium and Radium isotopes) and heavy metals (including copper, arsenic and lead) Potential receptors are visitors, residents, students, worker population and the flora and fauna in the area The site is listed on the 1995 Federal Facilities Compliance Docket

1906 to 1959 - Copper ore was mined
1951 to 1969 - Uranium ore was mined
1987 - NPS acquired full title to the property
1993 - NPS Western Region conducted a Preliminary Assessment The "score" was not high enough to include the site on the National Priorities List Because of human health concerns due to the radiation present, it was recommended that the site be remediated
1996 - A human health Risk Assessment (RA) was performed to set cleanup goals for the site

GENERAL PROJECT DISCUSSION The National Park Service is the lead agency under CERCLA The Orphan Mine site needs additional site characterization before a preferred cleanup method is chosen The EPA has offered technical assistance and technical review services

NPS is investigating PRPs and is working toward cost recovery All work associated with the project shall conform to CERCLA All costs associated with site work and project support must be recorded Preliminary and the NCP decision document must be FOIA protected

Park management has decided that the site needs to be cleaned so that no site or visitor use restrictions remain in place

All decisions must
1 - Take into consideration all previous work and decisions
2 - Consider human health and environmental protection
3 - Conform with the NCP and CERCLA
4 - Conform with the requirements for enforcement (cost recovery)

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ISSUES AND CONCERNS

Air Quality (Lead by Carl Bowman)
Particulate air monitoring for radionuclides at several locations in the park (one location is across the street from the site) has been performed by the State of Arizona The park has not been informed of any levels that exceed maximum contaminate levels Air monitoring protocols need to establish during the cleanup and any soil disturbing activities

Water Quality (Lead by John Rihs)
Analysis of samples from a spring, located down gradient from the site and adjacent to Horn Creek, revealed Alpha particles up to 95 picocurie per cubic liter during peak flow This information is in direct conflict with the information presented in the 1996 Risk Assessment The RA performed minimal water sampling and assumed there was no surface or groundwater contamination issue NPS and EPA agreed that this new information would raise the P/A scoring of the site NPS and EPA also agreed that it would not be necessary for EPA to perform HRS scoring Water monitoring of the creek, spring and mine drainage needs to be established to assess the source of the spring contamination Since an alternative that would require soil disposal down the mine shaft is to be evaluated, the potential effects to groundwater must be investigated

Human Health (Lead by Jere Johnson and Steve Dean)
Field monitoring of the site by EPA showed the potential for significantly increase exposure to visitors and works passing through the site area EPA requested that the fence surrounding the mine site be extended to include the entire contaminated area (including the concrete wall at the south corner) Appropriate signage is also needed

Threatened and Endangered Species (Lead by R V Ward)
A Peregrine Falcon nest neighbors the upper mine site Nesting time for the Peregrine is May - early - August Disturbance of the nesting pair during investigation and cleanup must be avoided The Century Milk Vetch is located on the ridge to the east of the upper mine site Since there is a chance the plant species may be located within the upper mine area, an assessment needs to be performed

Historic (106) Compliance (Head frame and building foundations)
The site has been determined eligible for the National Register of Historic Places It appears as though the head frame will need to be removed to completely clean the site Core samples of the foundations need to be taken to test for commination Consultation with the State Historic Preservation Office is ongoing

Native American Graves Protection and Repratriation Act (NAGPRA) (Tribal Consultation)
Local Tribes will be informed of the issues associated with the site Grand Canyon will take the lead in consolation and NPS will make all efforts necessary to assure Tribal concerns are addressed

Soil Removal
Soil removed from the rim area needs to be replaced with similar soil types This means another area of the rim would need to be disturbed to restore the upper mine area Due to the ecological concerns associated with the rim area disturbance at the Grand Canyon, fill material for the upper mine site is essentially non existent. The total amount of soil removed during remediation of the upper mine area needs to be minimized A 100% radiation survey of the upper mine area will allow the NPS minimize disturbance to the area

FOLLOW UP ACTIONS

National Park Service

- A 100% radiation survey of the upper mine site is needed to limit disturbance to the area during remediation Analysis of core samples from the concrete foundations for contamination will be performed

- Install fencing and signs around site in accordance with discussions with EPA (Need action memorandum)
- The Park will distribute copies of the sampling date (done)
- Monitoring and control of dust and contaminates in the air during the actual cleanup must be addressed in the EE/CA
- Perform ESI/RI (Expanded Site Investigation/Remedial Investigation) that will include Additional sampling at the spring and creek to determine if the contamination is naturally occurring or coming from mine drainage, Additional investigation of the road used to haul the ore from the site, Scan analysis and core sampling of soil, foundations and wall
- Explore the Bevel Exclusion and NPS landfill regulations (36 CFR 6) for project impacts
- Assessment of the site for the presence of the Milk Vetch
- Letter to EPA for formal request for ARARs
- 106 and NAGPRA consultations for the site
- Additional discussion with EPA on confidentiality

Environmental Protection Agency

- Formal request for fencing and signage at the site
- Provide NPS with additional technical language for 104(e) information request
- Provide sampling materials to sample vegetation at the site for radioactivity (DONE)

PROJECT POINTS OF CONTACT

NPS - Kris Provenzano will be the main NPS point of Contact for the Project

EPA - Jere Johnson will be the main POC for the EPA EPA will provide technical assistance and review

MEETING PARTICIPANTS
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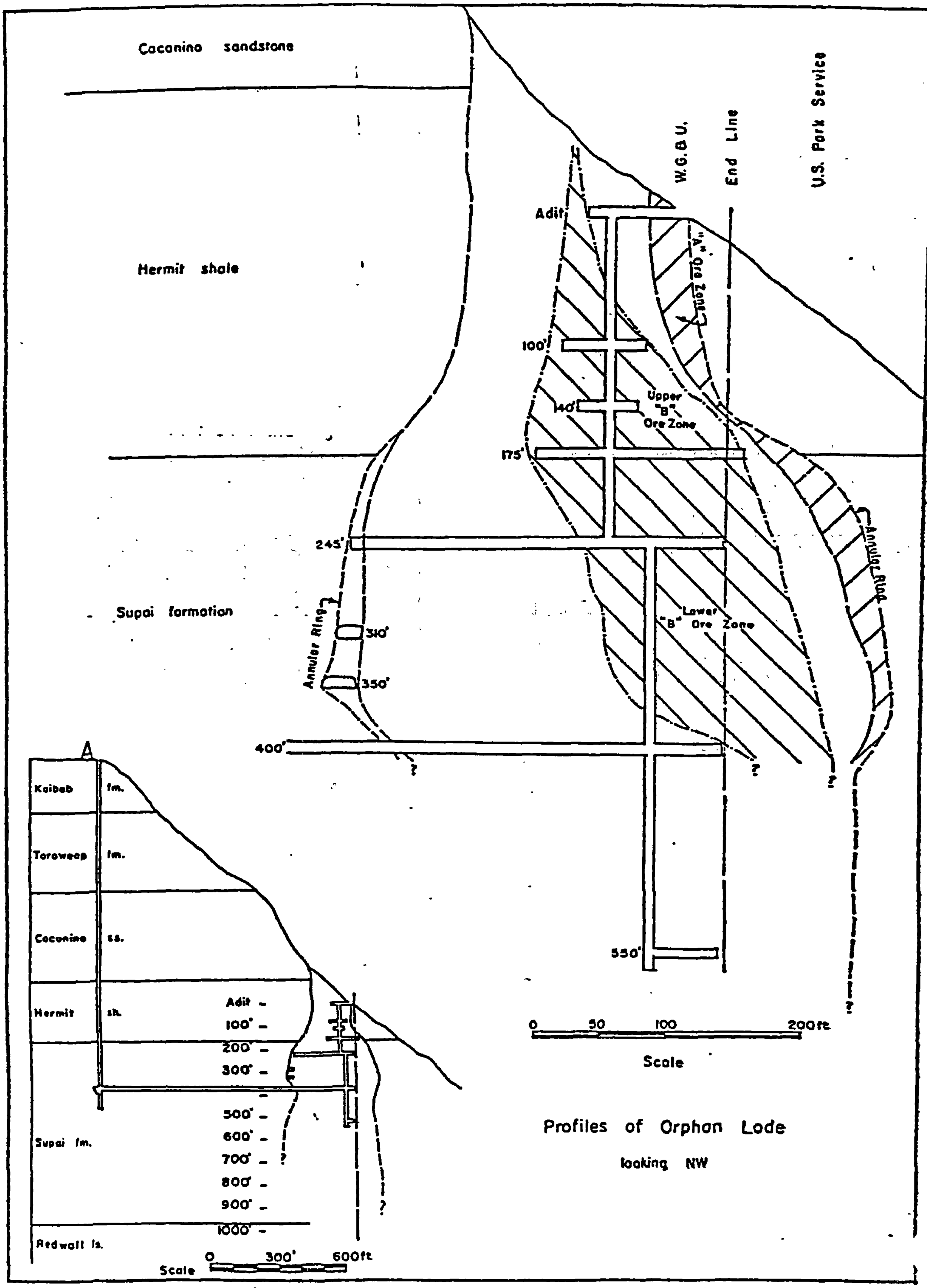

Figure 4 Orphan Lode Coconino County, Arizona

Reference: U.S.G.S., Grand Canyon National Park and Vicinity. Arizona, 1967.

Harding Lawson Associates
Engineering and Environmental Services

Site Location Map
Orphan Mine
Grand Canyon National Park, Arizona

PLATE **2**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
AM	22040-002	[signature]	12/92	